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DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

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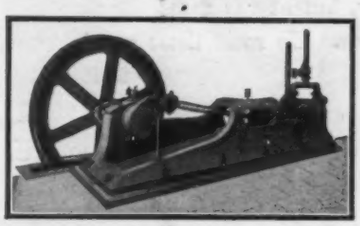

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This Happy Irishman

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Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XIV. SAN FRANCISCO, CAL., AUGUST, 1904. NUMBER 8

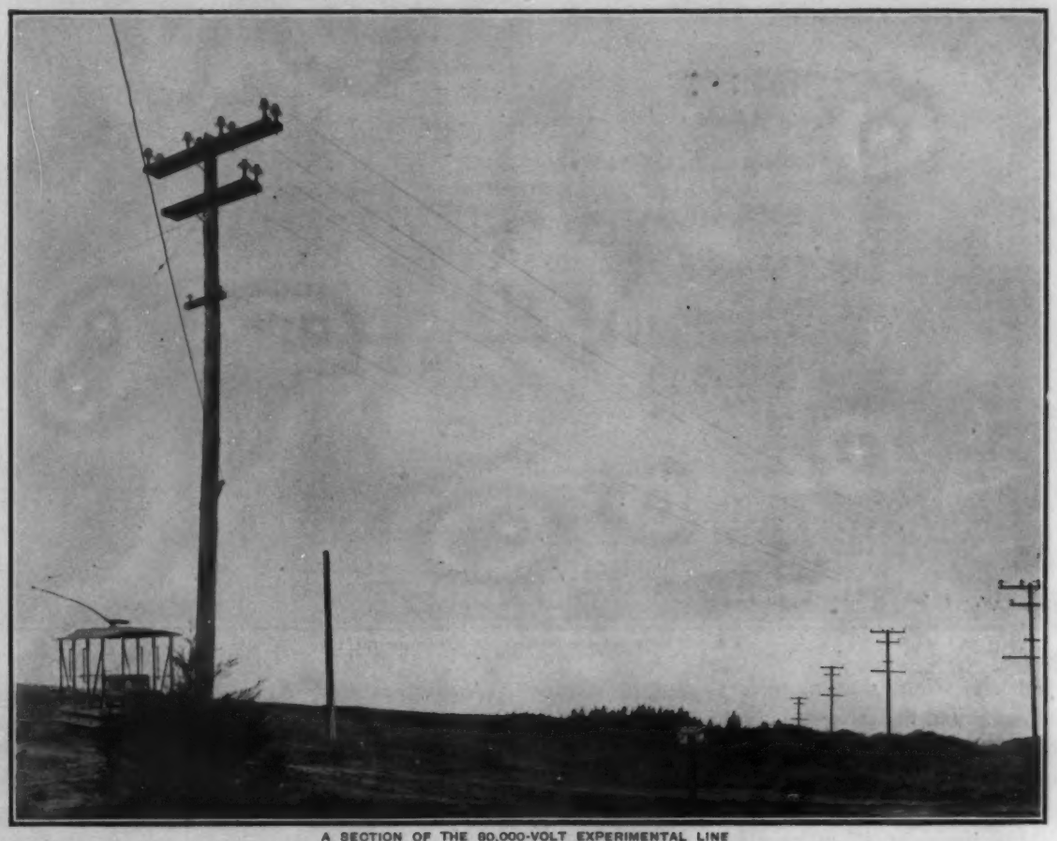
The Remaining Transmission Papers.

Concluding the Transactions of the Monterey Convention of the Pacific Coast Electric Transmission Association, June 21-22, 1904.

A SIXTEEN-MILE, 80,000-VOLT, EXPERIMENTAL LINE.*

BY A. C. BALCH.

EARLY in 1903 the discussion arose regarding the proper insulators to be used on the then proposed Kern River transmission line which was to be 125 miles in length, and to deliver at its terminal ten thousand horsepower. The copper had been determined for a working voltage of 45,000 at the power house, and 40,000 at Los Angeles with both lines working. The country about Kern River, however, having great water powers available, it was quickly seen that a higher voltage would be desirable in order to carry more power to Los Angeles over the same line. Accordingly Mr. W. G. Kerckhoff, president of the Pacific Light and Power Company, instructed that a test should be made of the various types of line insulators then on the market.



A SECTION OF THE 80,000-VOLT EXPERIMENTAL LINE

Nine types of insulators were available for testing and each type was installed part with wooden pins and part with metal pins; the cross arms being painted with metallic paint.

For convenience the insulators here are referred to as "Porcelain 3-14-29½"; the first figure being the number of pieces, the second figure the diameter of the largest

*A paper presented to the Eighth Annual Convention of the Pacific Coast Electric Transmission Association, Monterey, California, June 21-22, 1904.

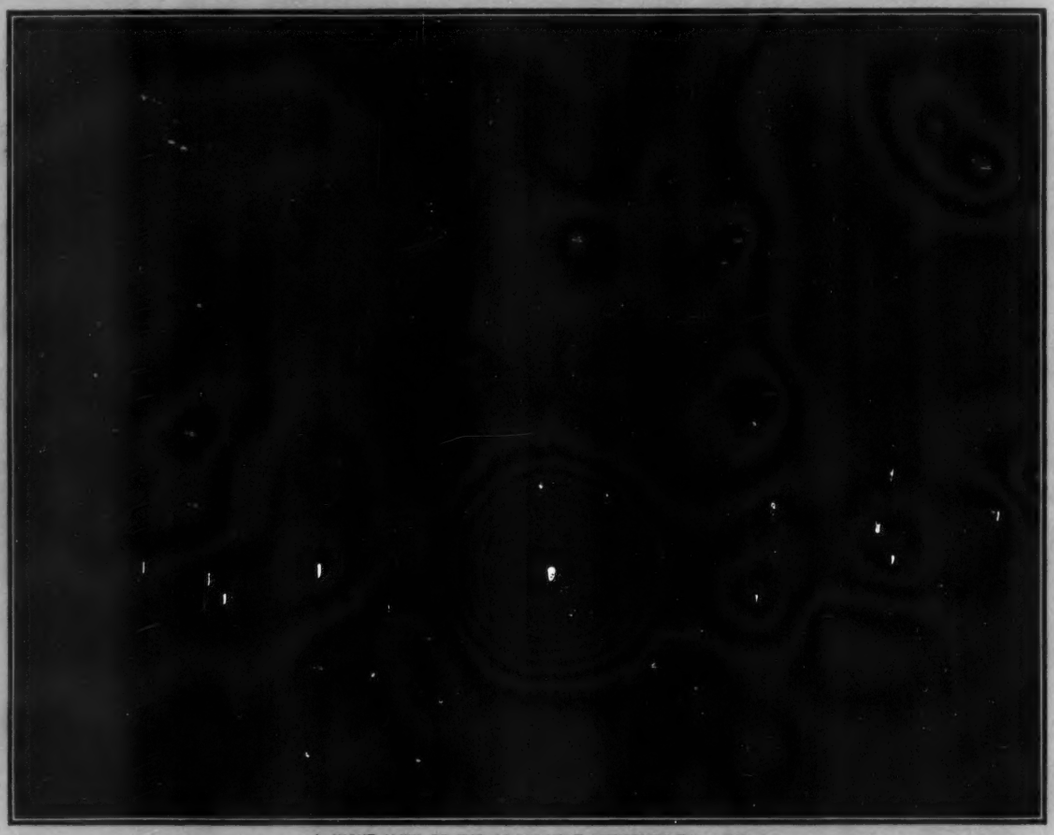
petticoat, and the third figure the creepage surface, *i. e.*, the actual surface distance between the wire and the pin. Stated in this way the insulators were as follows:

Locke Porcelain 3-14 29½
Locke Porcelain 3-11-28
Locke Porcelain 3-11-27
Locke Porcelain 2-11-25
Locke Porcelain 4-14-35
Locke Glass 2-11-23
Provo Glass 1-9-16
Muncie Glass 1-9-16¾
Knowles Imperial Porcelain 1-10-21
Allen Special, composed of 2-story Provo 1-9-16

A single insulator being mounted on top of two others with the cross piece supporting the upper insulator.

There was an average of 80,000 volts between two of the wires and the third wire. Only single-phase transformers were available, and these were two 40,000-volt transformers, which were connected in series with the center between the two grounded. Each transformer had a capacity of 250 K. W. Two of the wires were connected to one of the outside terminals of these transformers and one to the other. The current transmitted to the line was measured with a standard ammeter, which was placed in the line wires and set on top of the line insulator. This ammeter showed no apparent tendency to become inoperative on account of static charge. The current to the line was approximately 3 amperes, and this did not vary more than 5% at any time during the test.

The size of the wire was No. 4 B. & S. gauge.



A NIGHT VIEW OF THE 80,000-VOLT EXPERIMENTAL LINE

On April 1st a line sixteen miles in length having three wires mounted in triangular shape with a distance of 40" between wires was started up. The test continued until June 1st. During this time all sorts of weather was experienced, including heavy fogs and light and heavy rainfalls. In one night 4" of rain fell on the country through which the line was bulit.

The line ran east and west through the San Gabriel Valley, about one mile from the foot of the Sierra Madre range and parallel to the same.

During this test the usual experience of having no difficulty whatever with new insulators was most prominently noted.

A sharp rattling sound was in evidence, which seemed to be localized at points along the wire varying from one pole length to a half pole length, but could never be placed. It is difficult to determine whether the noise actually shifted or whether it was an error due to the listener. At times it seemed as though objects extending up from the ground, like neighboring trees and poles standing in the line, made greater noise apparent in their locality, but this was not definitely found to be the case. No danger could possibly have come to a lineman by his thinking the current was off when it was on as the sound could easily have been heard a hundred yards from the line at any time. A native of the locality said that the line sounded

like bees, and a great many of them. A reduction of 20% in the voltage practically stopped all the noise.

The line was luminous on a dark night or when looking toward a dark mountain on any night, and presented the appearance of a stream of bluish light about three inches in diameter for each line. This line did not show any nodes or extra brilliant points, but seemed to have exactly the same luminosity throughout its entire length. There was no extra intensity of brilliancy at the insulators or any other place, except at the tie wire on the top of glass insulators it seemed to somewhat enlarge the luminous volume which appeared as a somewhat brighter point than the other portions of the wire. The single wire, however, was considerably brighter than the other two, and could be seen at times and conditions of darkness when the other two wires were not in evidence, although the glass insulators on the other two wires were in evidence.

In extra dry times the luminosity was somewhat greater and was frequently reported to be visible a half mile from the line, and was seen on many occasions as far as a mile from the line. The luminosity was of such a nature as to actually illuminate the surrounding objects, which made very perceptible shadows. A camera set at the power house clearly showed ten spans of the single wire and showed three insulators on each of the poles in question. The telephone insulators on the first two or three poles were also evident in the photograph.

A telephone line ran about six feet below the lower cross arm, and this line was charged so that it would flow one-half ampere through 100 ohms; *i. e.*, it would light a 32 c. p. lamp of half candle power when connected directly between the combined telephone wires and ground. On open circuit, however, either of the telephone wires would discharge a spark 4 inches long to ground terminal. In spite of this, however, the telephone was easily used, provided the operators were willing to chance the conditions of static charge. This was only tested by standing on insulated stools and not used for regular work.

No difficulty was experienced in throwing the current on the line during a fog or in any other weather.

One day after a Locke 2-11-23 was put on the line the outer piece was found to be split vertically through the top groove, but the inner piece held the voltage successfully except for a small amount of arcing, which caused the patrolman to shut the line down the next day and replace the insulator.

On April 18th, a Knowles Imperial Porcelain 1-10-21 broke down and burned the top off the pole, making a short circuit and shutting down the line. This porcelain insulator was split down from the top a little to one side of the center in a manner similar to that shown by the Locke which had previously broken.

On April 29th, a Muncie glass 1-9-16¾ broke down, shutting off the test. This insulator also had a vertical crack as though it were split down from the top and parted through the threads letting it drop free from the pin.

On May 21st, a Knowles Imperial Porcelain 1-10-21 was broken off and carried away the top of the pole down as far as the second cross arm; the wires remaining clear until the arms fell, thus bringing the wires into direct contact.

During the entire test three wires on the other side of the poles, spaced with the same 40-inch distance, carried a 3-wire 15,000-volt line which was doing regular business and no difficulty whatever was experienced with it.

The conclusions arrived at by this test were that all is well while the insulators are new, or during any period when the insulators have no dust which can become mixed with fog or moisture by weather conditions.

No difference was experienced between wood and iron pins and in no case did the current short circuit from the wire to the pins over the insulators.

The results pointed out to the Pacific Light & Power Company were that it would be well enough to use a large

Locke "329 Porcelain, 11" Diam.
Locke "25 Glass. 7" Diam.
Locke "329 Porcelain, 14" Diam.
Locke "327 Porcelain 14" Diam.
Locke "331 Porcelain, 11" Diam.
Muncie Glass. 9" Diam.

TYPES OF INSULATORS USED IN 60,000-VOLT LINE EXPERIMENTS

insulator. Their general knowledge of porcelain led them to adopt for the Kern River line a brown porcelain and the insulators were made of four pieces. The insulator was not unlike the usual 15-inch Locke insulator, known as No. 329. The only difference between the Kern River insulator and the Locke No. 329 is that the inner petticoats are spread somewhat in order to allow the company to apply what they consider to be the cure for all evils. This cure, which was to keep the insulators in as good condition as new for an indefinite length of time was to have the lineman climb the pole once or twice a year, varying with the local conditions, and wipe out the inside of the insulator thoroughly with a cloth in order to remove the dust which might be collected there, at the same time inspecting the pole top carefully. This, it is believed, will keep the insulators as good as new, and if they are so kept the company feels safe in assuming that 66,000 volts will cause them no difficulty whatever.

SINGLE-PHASE POWER MOTORS.*

BY R. B. ELDER.

SOMEONE has said we advance in knowledge as we climb on other men's shoulders; that knowledge, and sometimes wisdom are accumulative. The meat of this article is to a very material extent furnished from the large experience and opinions of Mr. W. A. Layman of St. Louis, who for so many years has consistently devoted his entire time and energy toward the development of, first, the single-phase power motor; and second, the correct appreciation of the field of single-phase distribution.

At the last meeting of this Association at San Rafael, an interesting paper was delivered by Mr. H. A. Bullard, which went into the characteristics and physical capacity of a properly designed single-phase motor, and therefore we shall endeavor to only continue the subject.

The Central Station, or Transmission Company, must essentially consider the single-phase motor from two points of view: (A) The satisfactory performance of the motor under all conditions of usage, assuming that the current service be satisfactory; (B) The relative cost of other systems of installation; the simplicity of operation, and efficiency. All these providing the motor be entirely satisfactory.

The first consideration is the manufacturer's problem and unless solved by him there is no occasion for a discussion of the second.

The writer's remarks on this subject are based on the following assumptions:

First—That the single-phase motor, except for variable speed work, is to-day the substantial equivalent of the direct current motor.

Second—That polyphase and single-phase types of motors are not competitive.

Third—That simplicity of generating equipment and system of distribution are of paramount importance in the profitable development of central-station service, and on this point is laid emphasis.

In such a discussion, central stations divide themselves naturally into two classes—the large and the small.

The writer's views as to the proper form of alternating current equipment and distribution for these two types of plants, are as follows:

(*a*) For Large Plants—

Polyphase generators, with switchboard arranged for operating:

First—Polyphase feeders for all large power and rotary converter service.

Second—Single-phase feeders for all general lighting service and for all small-power work, the switchboard facilities being such that any single-phase feeder may be switched to either phase of the generator 'busses. Where a system of substations is employed, feeders from main to substations should be polyphase with provision in the substation for polyphase power distribution in large units, and single-phase distribution for all other kinds of service.

Third—Independent feeder regulators for all polyphase as well as single-phase feeders.

(*b*) For Small Stations—

Either single-phase generators with single-phase feeders, each feeder being operated with independent pressure regulator; or polyphase generators, with single-phase feeders that may be thrown by the proper switchboard devices to either phase of the generator, and each feeder provided with independent pressure regulator.

This policy with respect to station and distribution equipment is advocated in the conviction that the single-phase power motor affords the alternating current station, polyphase, or single phase, the ideal means for distribution of small power; also on the assumption that no valid reason exists why small-motor service should not be given from incandescent-lighting distribution mains. I take it that every central-station operator prefers single to polyphase distribution, and that no central-station engineer will extend polyphase distribution beyond the limits of actual necessities from an economical and engineering point of view. It therefore remains only to establish clearly in any given locality the extent to which single-phase distribution meets all actual service requirements.

Coming in contact with central-station men, in an endeavor to widen the use of single-phase motors, has enabled the writer to state that some difference of opinion exists between central-station men as to the extent to which single-phase motors should be employed and central-station distribution systems correspondingly modified. This difference of opinion arises from doubt, on the following points:

First—That the single-phase motor is a reliable device.

Second—That the cost of installation of the single-phase motor is actually much less than that of the polyphase.

Third—That satisfactory single-phase motor service can be given from polyphase generators.

Fourth—That single-phase motors can be satisfactorily operated from lighting circuits.

That the single-phase motor is a practicable and most reliable device is evidenced by the fact that approximately in Chicago alone are 1500 units operating. There are many hundreds in Boston, Philadelphia, St. Louis, and in the many small towns, thousands. On the Pacific Coast there are over 1200 motors, in sizes ranging from 1-4 to 30 H. P., and on this Coast most of the largest motors from 10 to 30 H. P. are operating from polyphase circuits.

Several manufacturers now advertise single-phase motors, and the company that I represent has been building them, with great success, since 1897. There is no question, however, that considerable skepticism exists as to the complete success of this type of motor. This skepticism is largely the outcome of several early attempts to

*A paper presented to the Eighth Annual Convention of the Pacific Coast Electric Transmission Association, Monterey, California, June 21-23, 1904.

exploit synchronous single-phase motors that were complete failures. There is also some indifference to the virtue of the single-phase motor where the polyphase system has been installed, and operating engineers are not familiar with the degree of success attained elsewhere with the single-phase motor. There are many central station engineers in this Association, however, who will bear me out in the assertion that at least one type of single-phase motor on the market to-day is thoroughly reliable and is comparable in practically every respect to the best shunt wound direct current motors, and also the best polyphase motors.

COMPARATIVE COST OF INSTALLATION OF SINGLE AND POLYPHASE MOTORS.

I have said above that polyphase and single-phase motors are not competitive. From the manufacturer's point of view they may be to some extent, but from a central station and engineering point of view they are strictly non-competitive. The cost of installing a polyphase motor is so much in excess of the cost for a single-phase motor, that no central station can afford to give polyphase motor service where single phase will meet the requirements. This excess of cost consists in line wire, cross-arms, step-down transformers, secondary wiring, meters, etc. An eastern central station engineer has stated that he has been able to effect a saving of $100.00 in the first cost of service equipment for every 5 H. P. to 10 H. P. single-phase motor installed. The saving for the larger sizes of motors is considerably greater. As indicating the saving in transformers I would refer you to Fig. 1 in Mr. Bullard's paper of last year, in which there is a comparison of transformer costs for single, two or three-phase motors. This comparison would still hold good as transformers prices to-day have practically not changed.

This comparison is based on the adaptation of standard sizes of transformers. It will be observed that the excess in cost of transformers varies from about 25 per cent., for two-phase motors, to an average of about 50 per cent. for three-phase motors, operating on two transformers. There is a further substantial and constant central station saving in the core and copper losses of transformers, arising from the losses of two or three small transformers for a polyphase motor greatly exceeding those of one transformer for the same capacity in single-phase motor.

The investment saving alone is leading some of the largest central station companies to *require* single-phase motors for all installations within certain capacities. Taken with the saving in transformer losses, and the simplification of distribution system, this relatively low cost of installation is bringing about a radical change of ideas as to alternating current distribution. One well-known engineer has stated that the saving in pole-line space arising from the use of single-phase feeders is alone a sufficient argument in favor of single-phase motors. Within the last year it has therefore come about that some of our best and largest companies are no longer attempting a general polyphase distribution, but now run our polyphase feeders to large power units only.

SINGLE-PHASE MOTORS ON POLYPHASE GENERATORS.

The small central station has very little use for a polyphase generator. In not one small town in a hundred does there exist a single instance of power service that can not be adequately handled with a single-phase motor. As an instance of this, the town of Biggs, near Chico, is putting in an electric distributing system for power and lighting. They will take current from the circuits of the California Gas and Electric Corporation, which is a three-phase transmission, but there will be installed only 1-100 K. W., lowering transformer. This transformer will furnish current for lighting and power in the municipality. The largest motor will be a 30 H. P., single-phase motor, driving the pump to supply water for domestic and fire purposes.

A few years ago this was not the case, and some polyphase generators were installed in small towns. Recently many of these have modified their switchboard arrangement and are now operating generators as single-phase machines at approximately 80 per cent of the polyphase rating. In the larger cities, polyphase generators are justifiable, the multiplicity of single-phase circuits alone making them desirable. Single-phase service can be satisfactorily given from any polyphase machine. All the plants of the Public Service Corporation of New Jersey, approximately fifteen in number, all those of the United Gas Improvement Co., also of the Boston Edison Company, the Philadelphia Electric Company, the Chicago Edison Co., the Cincinnati Gas and Electric Co., the California Gas and Electric Corporation, and a great many others, are giving thoroughly satisfactory single-phase motor service from their polyphase plants, and also from polyphase feeders. These stations are coming to regard the single-phase motor as offering difficulties not appreciably greater than an incandescent lighting load of the same size subject to sudden application to their systems. I am informed that two of the largest syndicates—namely, the Public Service Corporation of New Jersey and the United Gas Improvement Company—have determined upon a central station policy that calls for adherence, as closely as possible, to polyphase generators governed by automatic pressure regulators with single-phase feeders controlled by individual pressure regulators. I am also informed that these companies have inaugurated a very energetic policy of expansion of single-phase motor service, using many of the same expedients to secure single-phase motor subscribers as are used by some of the leading gas companies in extending fuel gas consumption. The balancing of the load on a polyphase system becomes in a considerable measure of minor importance when individual feeders are equipped with pressure regulators.

In the city of Chicago, the outlying substations are fed from the main generating plants by three-phase, four-wire trunk lines. From substations singlephase feeders are

carried out, each of these feeders running from one side of the three-phase circuit and the neutral. Each single-phase supply circuit is equipped with an individual pressure regulator, and each feeder thus becomes absolutely independent of all other feeders, both as to load and pressure regulation. It is the practice in a great many polyphase plants to require the installation of single-phase motors for all service connections up to a certain point, and to give preference to single-phase installations above that point where the general distribution system will take the load without disturbance of lighting service. The Public Service and United Gas Improvement Companies are installing single-phase motors up to and including 35 H. P. The Cincinnati Gas and Electric Co. is using single-phase motors of fifteen or less horsepower capacity, and considering larger installations individually on their merits. In Chicago, I am informed that motors of five H. P. or less are *required* to be single phase, and larger installations are considered individually on their merits.

Sentiment is constantly changing, and the next year will see a rapid development of the policy of throwing down the bars to single-phase motor musiness and confining the use of polyphase motors more and more to large-service installations.

SINGLE-PHASE MOTOR SERVICE FROM LIGHTING CIRCUITS.

The difficulty of giving satisfactory motor service from lighting circuits, without the disturbance of lights, has been very largely overestimated. It is Mr. Layman's opinion that the factors necessary to satisfactory single-phase motor service from lighting circuits, in the order of their importance, are about as follows:

First—The control of feeder pressure by means of individual feeder regulators. The cost of these regulators is negligibly small when their value in the elimination of service difficulties is fully appreciated.

Second—Adequate feeder capacity for an equivalent total load of incandescent lighting.

Third—A sufficiently large and properly selected type of transformer. A transformer suitable for incandescent service will not necessarily be suitable for motor service, as some of the commercial makes of transformers that give good regulation on lighting load give very poor regulation on motor load. A properly selected lighting transformer will be entirely adequate for good motor service.

Fourth—Installation of the single-phase motor in such a manner as to hold down the current demand from the circuit in starting.

This last consideration comes back again to the operating characteristics of the motor. The motor with which I am most familiar, namely; that manufactured by the Wagner Electric Manufacturing Company, possesses two characteristics that contribute admirably to the minimizing of disturbance effects of frequent starting. These characteristics are:

(*a*) A very high power factor of starting current, without condenser.

(*b*) A large excess of starting torque, which permits the use of a non-inductive starting rheostat, making possible the holding down of the starting current without loss of sufficient starting capacity.

The Wagner type of motor starts as a repulsion motor and at the instant of starting develops a torque of two and one-half times full load torque for full load current, or five time full load torque for the maximum rush of current when rheostat is not in use. In sizes of 5 H. P. and less, it is the usual central station custom not to use starting rheostat; for the larger sizes starting rheostats are now quite generally used. These boxes are of the standard direct current type, without automatic release, and when used, the starting power factor on the motor varies between 90 and 95, developing full load torque from rest to full speed with a current that does not exceed one and one-fourth times full load current. Where the motor load varies between wide limits and is of a pulsating character—which tends to set up current waves in the feeder—it is advisable to install a small flywheel, which serves to straighten out the current demand. Where large motors are located at the end of long feeders, it is also frequently desirable to require the starting of these motors on an idle pulley, in which case a negligible disturbing effect results. It is always well to use a transformer of ample capacity, since good single-phase motors are capable of carrying temporary overloads of from *30 to 50 per cent.* They will not develop such loads, however, without corresponding transformer capacity.

For normal full load, it is usually necessary and sufficient to install about one kilowatt of transformer capacity for one horsepower of motor capacity on 60-cycle circuits.

THE DESIRABILITY OF MOTOR FOR CENTRAL STATIONS.

The energetic development of a motor load on large distributing systems is very apparent in many plants, but we may particularly refer for instance to the history of the Chicago Edison Company, and the Commonwealth Electric Company. On January 1, 1899, the average power load on the Chicago Edison Company's circuits was 24 per cent. of the total load; on July 1, 1903, the average power load became 46½ per cent. of the total load. That the Chicago Edison Contracting Department was not neglecting the lighting business is evidenced by the very handsome increase of 124 per cent. in lighting load. The energy with which the motor business has been pushed is indicated by the remarkable increase of 335 per cent. in motor load. These statements are taken from plotted curves furnished by Mr. Louis A. Ferguson of the Chicago Edison Company, and leave no room for doubt as to why this Company is meeting with such splendid success in its business.

A central station may be properly regarded as a manufacturing plant, and the same principles of operation apply to it as to any manufacturing institution. There must be the greatest possible simplification of output; production must be maintained on as nearly uniform basis

as possible; the full productive capacity must be sold and all by-products utilized in every available way. Until a few years ago, electrical central stations were essentially lighting stations, and many of them came into existence to do municipal street lighting. To-day, however, conditions are materially changed. Companies are incorporated, and are giving service, as light, heat and power companies.

THE SPECIAL VALUE OF MOTOR LOAD TO SMALL STATIONS.

There has been a rapid increase, in the East more than on this Coast, in the number of small stations giving heating service. To such plants motor business is an absolute necessity, as otherwise steam necessary for heating service ceases to be a by-product, and the profitable conduct of a heating system by an electric lighting plant becomes doubtful. Stations with auxiliary heating service can afford to offer extremely liberal inducements in the way of low rates for motor business, and the single-phase motor becomes an especially valuable adjunct under such conditions. There is a rapidly increasing number of instances where small central stations, through the medium of single-phase motors, have been able to take on the municipal pumping service; for instance, the city of Biggs.

THE DAY CIRCUIT AS A FACTOR IN THE BUILDING UP OF SMALL TOWNS.

It is a remarkable fact that the small central station, or distributing station, giving day motor service is one of the strongest elements in the building up of a small town. Labor and other conditions in the large cities are forcing the establishment of small branch factories in outlying towns and villages. These branch factories are usually small institutions, individually considered, and it does not pay to operate power plants in them. Such factories gladly become power subscribers for the central station, and the ability to get this kind of service influences the location of many a plant of this character.

POWER RATES FOR SINGLE-PHASE MOTOR SERVICE.

Frequent inquiry is made as to the proper rates to be charged subscribers for motor service. As indicating the rates in force by several Eastern companies that are actively pushing the motor business, the schedules of the Peoria Gas & Electric Company of Peoria, Illinois, and the Cincinnati Gas & Electric Company, are appended:

ALTERNATING CURRENT POWER RATES OF THE PEORIA GAS AND ELECTRIC COMPANY, PEORIA, ILL.

0	to	100	KW hours consumed during 1 month,	10	cents	per KW hour
101	to	200	KW hours consumed during 1 month,	9	cents	per KW hour
201	to	300	KW hours consumed during 1 month,	8	cents	per KW hour
301	to	400	KW hours consumed during 1 month,	7	cents	per KW hour
401	to	500	KW hours consumed during 1 month,	6	cents	per KW hour
501	to	700	KW hours consumed during 1 month,	5	cents	per KW hour
701	to	1000	KW hours consumed during 1 month,	4	cents	per KW hour
1001	to	1500	KW hours consumed during 1 month,	3.5	cents	per KW hour
1501	to	2000	KW hours consumed during 1 month,	3	cents	per KW hour
Over		2000	KW hours consumed during 1 month,	2.8	cents	per KW hour

Ten per cent. discount on all bills paid before or on the tenth of the month.

ALTERNATING CURRENT POWER RATES OF THE CINCINNATI GAS AND ELECTRIC COMPANY, CINCINNATI, O.

	Discount.
On consumption in 1 month of less than 100,000 watt hours,	10 per cent
On consumption in 1 month of 100,000 to 200,000 watt hours,	20 per cent
On consumption in 1 month of 200,000 to 300,000 watt hours,	30 per cent
On consumption in 1 month of 300,000 to 400,000 watt hours,	40 per cent
On consumption in 1 month of 400,000 to 500,000 watt hours,	50 per cent
On consumption in 1 month of over 800,000 watt hours,	60 per cent

Base rate, 10 cents per 1000 watt-hours.

Additional discount of five per cent. for the payment of bills on or before the fifth day of the month following date of bill.

The tenor of this paper considers the single-phase power motor principally from the commercial standpoint, and it might be continued at some length. The remarks, however, will suffice as a basis for further discussion of the subject in open meeting.

HIGH PRESSURE WATER WHEELS, WITH PARTICULAR REFERENCE TO THE GIRARD AND FRANCIS TURBINES.

BY E. G. DE WALD.

IN compliance with a request from your Executive Committee for a paper descriptive of high pressure water wheels, I have prepared the following remarks, but I wish first to thank you for the honor which this invitation confers.

From several years' acquaintance with you, I know that you are especially interested in turbines suitable for high heads. The turbine or hydraulic wheel that I will first describe is in every way suitable for heads varying from 200 to 2000 feet, thus covering the range to be found in general practice.

The name turbine is derived from the Latin word "turbo," and was given this machine by Fourneyron, a French civil engineer, in the year 1833, when he developed the first turbine water wheel. A number of engineers, observing the advantages of the first turbine, which gave an efficiency of 73 per cent., soon invented new types. Henschel & Son, of Germany, reported a patent in 1837, Jonval and Fountaine followed, in France, and Francis brought out a new type in America in 1849. All these different types, if we may call them such, were designed and built according to the principle of reaction, and there was nothing very new or radical in their construction. In 1863, however, L. D. Girard, a French engineer, read a paper before the French Academy of Science, in which he first advanced the new principle of high head wheels which bear his name. Wheels of this type—that is, of the Girard type—have been extensively built in Europe, but comparatively few have thus far been used in this country. Thus it is evident that the Girard water wheel is not a radically new turbine, built on entirely new principles, but one which has been developed and operated most successfully for a number of years, for its manufacturers have studied its principles and improved

*A paper presented to the Eighth Annual Convention of the Pacific Coast Electric Transmission Association, Monterey, California, June 21-23, 1904.

its details, and have perfected an apparatus that is flexible in its adaptability to the needs of power users and will satisfactorily meet every requirement.

The Girard turbine, technically known as the type "C" turbine, is illustrated in Figures 2 and 3. One of them

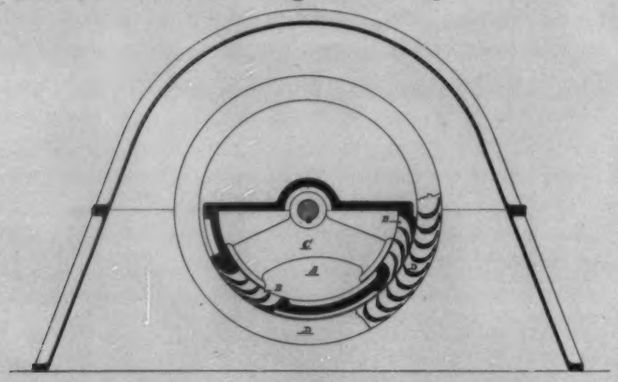


FIGURE 1

represents a cross-section showing the course of the water when flowing through the chute case and wheel runner; the other represents a longitudinal section showing the relative position of gate, chute case and runner when mounted together. The two dotted lines, marked "relative" and "absolute," are the two principal lines for the construction of these wheels—the relative representing the flow of water through the turbines when the runner is standing still, and the absolute line indicating the course of each individual part of the water were the wheel running at its proper speed. For instance, if a block of wood small enough to pass the openings of the case and runner were thrown inside the feeder pipe, it would follow the absolute line, as shown, and be discharged in the direction of this line; but were the wheel standing still, the block would follow the direction of the relative line. In a correctly constructed wheel the block of wood should leave

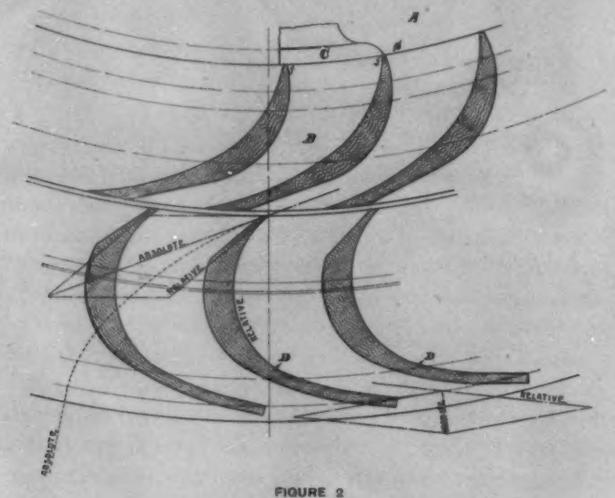


FIGURE 2

the wheel runner in an exact radial line, and the highest efficiency can be obtained only when it is discharged in this way. The parallelogram of the velocity of discharge acts as a check on the entire construction, and shows the designer whether the wheel is correct or not. Many of you are familiar with the manner in which this parallelogram is obtained; but to those who do not know, I would say that in it the builders of the Girard turbine have means to pre-determine the efficiency of water wheels, under any conditions, within 1 or 1½ per cent., and that by its use they do not necessarily have to descend to cut-and-try methods for their construction.

Referring to the gate mechanism and its relation to the chute case, allow me to explain its action. The chute case represented in Figure 1 has eight individual chutes. The gate is so designed that two chutes are completely opened or closed before any other individual chute is called into action. It is evident from this that each individual chute is independent of the next, and, too, that when such an individual chute is discharging water into the wheel runner there is not that loss in efficiency which would result were all the chutes partially opened at the same time by the gate. Since each chute is opened individually, I may rightly state that the efficiency and power of a cubic foot of water is the same under all conditions

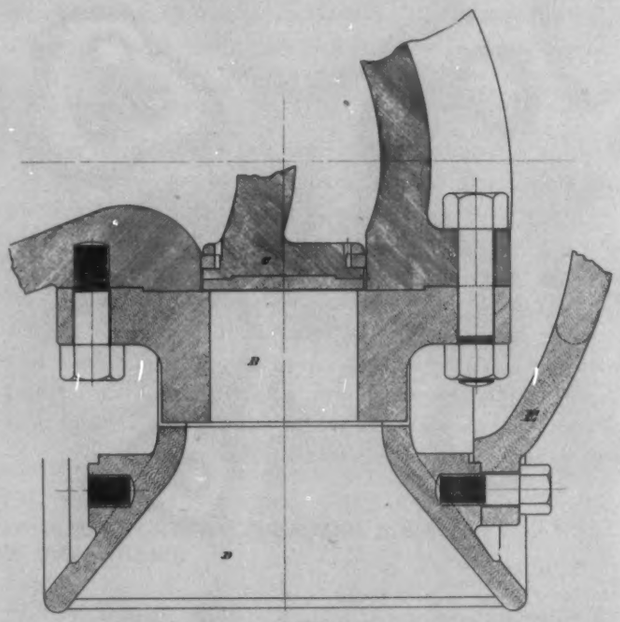


FIGURE 3

of gate travel. To convert the above reasoning into other terms, we may say that if a turbine discharges fifty cubic feet of water at one-half gate opening and 100 cubic feet at full gate opening, the efficiency obtained from the first fifty cubic feet is just as high as that obtained from the second fifty cubic feet. Regarding the power that can be obtained, it would appear that the first fifty cubic feet should give the same power as the second, which is true and correct, taking a cubic foot as a unit; but the power taken off the shaft will be less for the first half of the gate opening than for the second, for the simple reason that all the frictional resistances of the running or revolving parts of the turbine must be credited to the first half of the wheel, as these resistances cause the loss of power. If this were not so, the efficiency curve would be a straight horizontal line in diagram Figure 6.

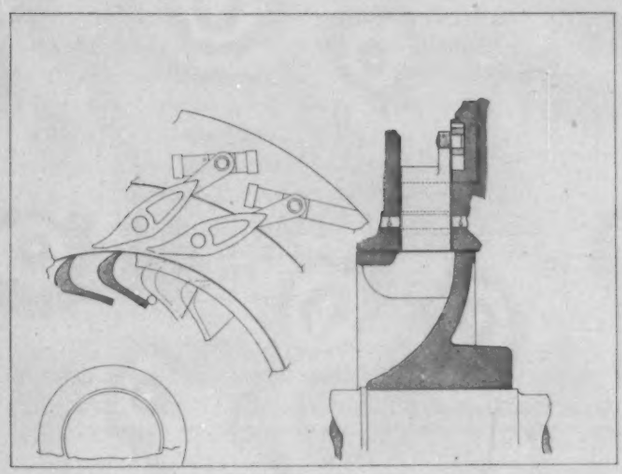


FIGURE 4

This diagram shows that the necessary water discharged through the first two chutes, or part thereof, to bring the turbine up to its required speed gives no power at all that can be measured on the shaft; but as soon as the wheel is up to the required speed, the efficiency curve assumes a horizontal direction, and as more chutes are opened the nearer does the efficiency curve become to a straight line.

The construction of the turbine permits a greater number of chutes or nozzles, and from the foregoing it is evident that the greater number of chutes we have in conducting the water to the wheel runner, the more powerful will be the turbine. Likewise, since the fractional resistance of all wheels of the same diameter is a constant, the average efficiency will be higher. The smaller we can get this constant, the greater will be the efficiency. For instance, if the constant is 5 per cent. of the total power, then the efficiency will naturally be higher than if the constant were 25 per cent. of the total power. To express this important point more clearly, let us assume that it requires twenty cubic feet of water to balance the frictional resistance, that is, to bring the wheel up to its required speed; and again, that another twenty cubic feet of water will be sufficient to furnish the power required. You will readily see that the efficiency as measured on the wheel shaft can not be high; in fact, will be very low; yet the forty cubic feet may give a very high rate of efficiency. If we accept the foregoing course of reasoning, we come to the conclusive fact that the multiplicity of chutes is highly beneficial to the construction of this type of turbine, and the most disastrous to the efficiency of other wheels whose makers claim your attention for high-head water power installations.

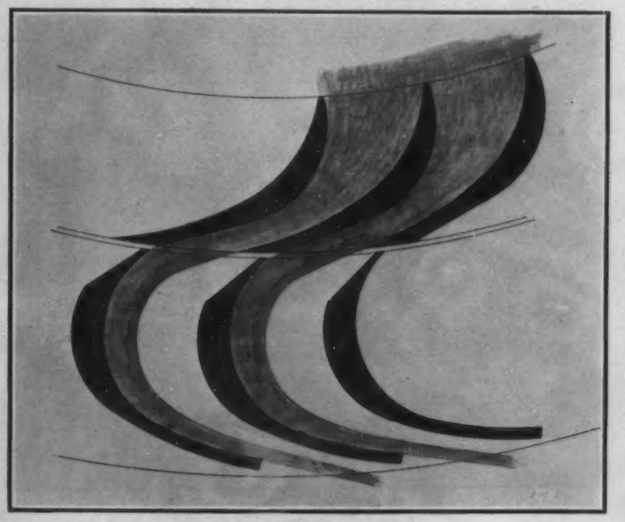


FIGURE 5

In the foregoing I have dwelt more or less on the technical side of the question, endeavoring to show and explain the general construction and the technical value of the Girard turbines. As to the commercial side, the several gentlemen here know full well that I am an exponent

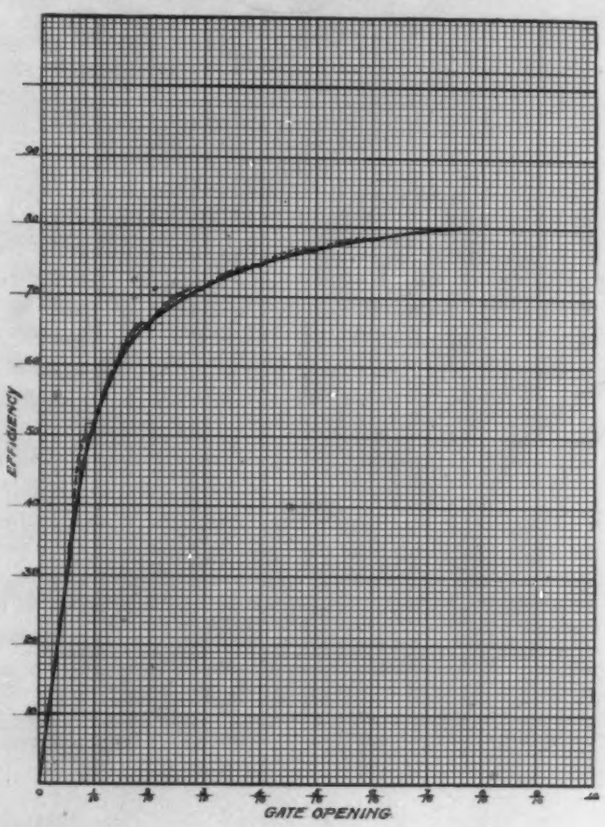


FIGURE 6

of high revolutions and large power for individual units. The question why I have done so is easily answered. You have heard that we prefer a multiplicity of chutes. In every single unit where we have a large number of chutes a great deal of water is discharged, this meaning a large power and high efficiency, which is exactly what every water power owner desires.

If you request my advice, stipulating a quantity of fifty cubic feet of water per second under a certain head, I will recommend a small wheel having a high rotative speed; because the high rotative speed means small proportions for the generator, and, again, small selling prices, which latter, in my experience here on the coast, has always been of great interest to you and never failed to draw attention.

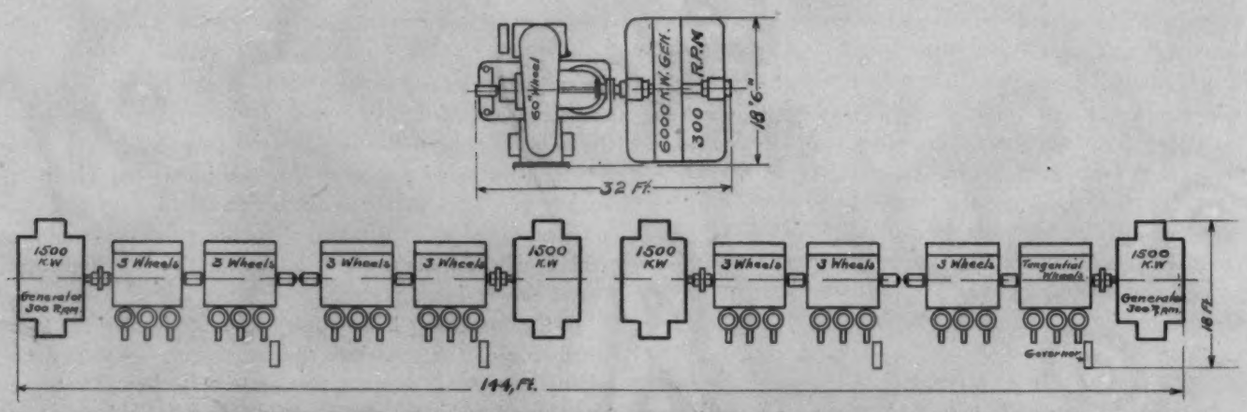


FIGURE 7. THE TWO DRAWINGS ABOVE, WHICH ARE DRAWN TO EVEN SCALE, GIVE THE COMPARATIVE FLOOR SPACES, RESPECTIVELY, OCCUPIED BY GIRARD AND TANGENTIAL WHEELS. EACH DELIVERS 10,000 HORSEPOWER, THE FORMER OCCUPYING, IN FLOOR SPACE, 592 SQUARE FEET AND THE LATTER, WHICH HAS FORTY-EIGHT NOZZLES, OCCUPYING 2592 SQUARE FEET

If we have high heads at our disposal, we do not need ponderous big wheels and generators revolving at slow revolutions. Our confreres and allies, the steam turbine manufacturers, have developed this branch so well that we do not need to exert ourselves in inventing mechanisms and new machine parts that will permit high speed. If we keep posted and look around we need only to adapt. Steam turbines of large power running between 500 and 1000 revolutions per minute are being installed to-day without even questioning the feasibility of their high speed. It is a matter of fact with them and no experiment whatever. Now then, is it consistent that the hydraulic turbine, no small factor at this time, is doomed to be barred from progress because of its inherent high speed?

If you have followed me you will know that all I have read thus far is in regard to the Girard turbine, technically known as the type "C" turbine. Another line that is of equal importance is the type "B," or the Francis turbine. In justice to Mr. Francis, who died some years ago, and whose name we should well preserve in our memory, it must be justly said that all American turbines, as The Victor, Hercules, Leffel, and others that are on the market, are but modifications of his design. Francis was the first to conceive the idea that a turbine, having its water conducted vertically toward the center of the wheel shaft, and discharging axially, or in the direction of the shaft, would have advantages that could not be found in any other turbine at that time. The Jonval was the turbine most preferred by all designers and power users; but in this design the water flows through both the chute case and the wheel runner parallel with the wheel axis; therefore the value of the Francis wheel must not be underestimated. It was quite a departure from the common idea at that time, and was not well thought of by his adversaries, certain German and French designers. They claimed that the pasage of the water through the chute case and wheel runner was a very difficult one, which could not give satisfactory results. Notwithstanding this, Mr. Francis' idea was adopted by his countrymen, the Americans, and it took thirty-five years or more to convince Europe that it was a good and proper design to recommend for heads from 10 to 300 feet. I say, up

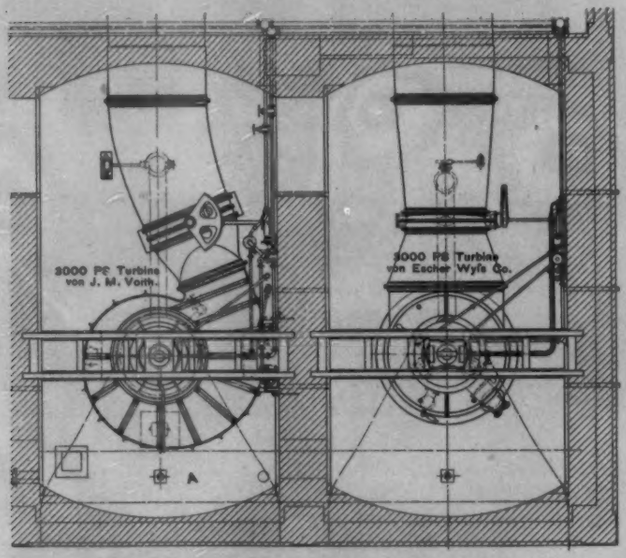


FIGURE 8. BY COURTESY OF ESCHER, WYSS & CO.

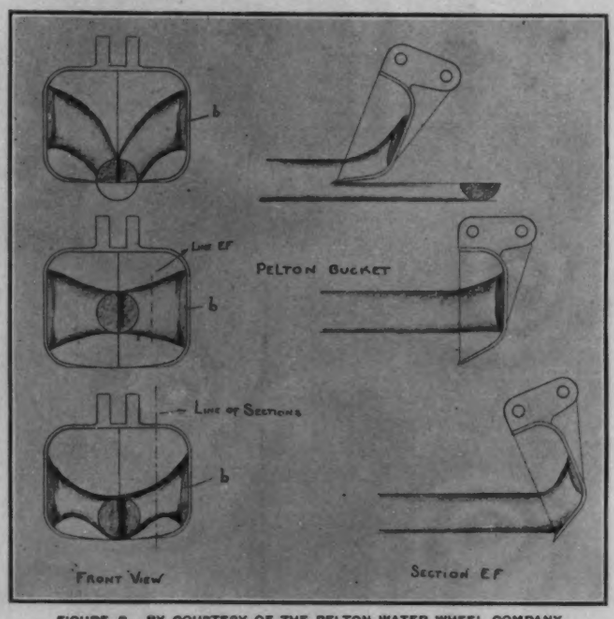


FIGURE 9. BY COURTESY OF THE PELTON WATER WHEEL COMPANY

to 300 feet head, but must restrict this somewhat, for when the speed and the horsepower will admit of its use, the Girard turbine should be used.

These two turbines, the Girard and Francis, or types "B" and "C" respectively, are the two types most commonly used in Europe, and they are certainly destined to become as commonly used in America. While, as mentioned before, all American wheels of the Francis type retain the same features as originally outlined by Francis, the American wheel, although it is classified as the Francis type, has undergone many changes during its long existence, and therefore can justly be classified as a type of its own, brought gradually by evolution to its present state of perfection. The theory of the Francis wheel of to-day is well defined and approved to be correct by all who have studied its design. As in a Girard wheel, the careful designer can closely foretell its efficiency; hence the wheel can not be looked upon as an experiment.

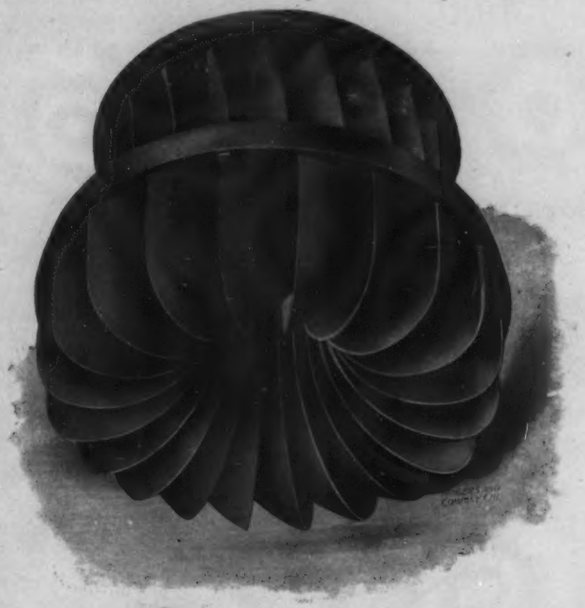


FIGURE 10. VICTOR TYPE A CYLINDER GATE RUNNER

In reference to speed the Francis type permits of more flexibility than any other type of wheel in the market. While the Girard type, for a certain diameter and constant head, can be changed only 1 per cent. to 1½ per cent., leaving the designer no flexibility, the Francis type of wheel can be changed in the ratio of 50 to 78. The efficiency curve for 50 is flatter than that of 78, and more like that for a Girard type wheel, but both designs are good and give satisfactory results for either speed.

Swivel gates have been used with all the type "B" wheels that have been installed on this coast, but this kind of gate is not absolutely essential. A cylinder gate can be used just as well, but there is a very marked difference in the efficiency curve for the reason that the swivel gate gives a much flatter curve. To overcome this difficulty—I may say ineffectiveness—a European manufacturer, Escher, Wyss & Company, has adopted a method of winding chute case guides, making the opening at one-fourth gate narrower than at full gate, claiming that a flatter efficiency curve is obtained; but how much this change is instrumental in its purpose I do not know.

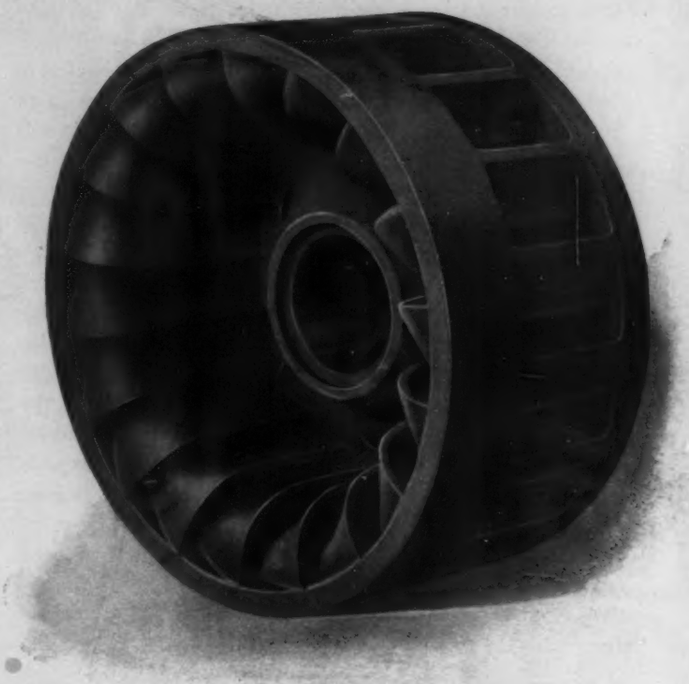


FIGURE 11. VICTOR GIRARD TYPE B HIGH PRESSURE RUNNER

It may be interesting to you to examine Figure 8, taken from a German periodical, illustrating a new power development in Norway. It consists of two vertical wheels of 3000 horsepower each, one wheel being equipped with a spiral flume and swivel gate, the other using a cylinder

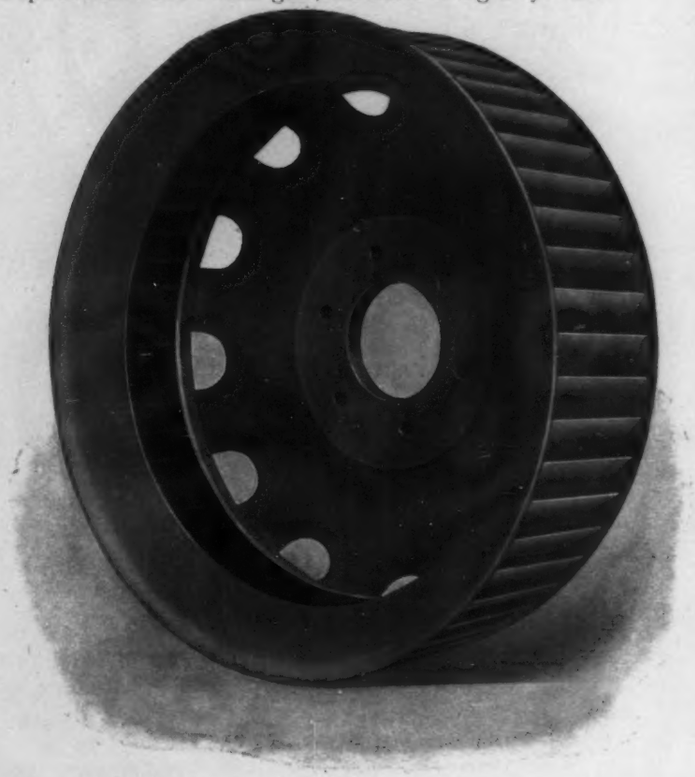


FIGURE 12. VICTOR FRANCIS TYPE C HIGH PRESSURE RUNNER

gate in imitation of American practice of many years. As to which is the better of the two I leave to your own judgment; but if nothing else is shown the fact is clearly demonstrated that this subject of water wheel gates is as yet open to discussion, and it is questionable if ever it will be closed. It is certain to my mind, however, that the swivel gate combines advantages that never will be approached by the cylinder gate.

As I have taken up much of your time, gentlemen, let me in closing tender my best thanks to the Pacific Coast Electric Transmission Association for the invitation to read this paper.

SOME EXPERIENCES IN THE REGULATION OF A THREE-PHASE, FOUR-WIRE, MIXED DISTRIBUTION.*

BY C. W. HUTTON.

ALL I have to offer is a short description of some troubles and the remedies applied to the three-phase, 200-volt, four-wire system which was installed in Sacramento when the plant was first built in 1895. I guess Sacramento will be credited as being the first town where a three-phase, four-wire, low-tension system was ever put into operation. Very little experience had been had at that time with overhead wires, carrying heavy alternating current. This line was originally built to feed a network which was about ten blocks long (the blocks being about four hundred feet square) and three blocks wide, the lines calculated to carry about 4000 sixteen-candle-power lamps. The number of feeders was seven, each consisting of three solid 4-0 wires feeding into a network, a portion of which network was slightly smaller than 4-0. These feeder wires were distributed on the poles after the ordinary method of construction, the wires being spaced 12 inches apart. When the line was constructed the wires were arranged in such a way that, designating the three wires of a feeder as A, B and C, the A wires were all placed next to the pole, the B wires coming next, and the C. wires on the outside end of the cross arm, reading from the center of the pole out. There being seven feeder circuits, there were three on one side, and four on the other side of the poles. The effect of this arrangement of wires was very peculiar when the maximum load was on. The A phase wires being all in a bunch down the center of the pole, and the Bs out to one side, and the C's on the other side, there was considerable of a churning effect, and we soon found, after the load had increased to any extent, that we had a very queer combination of voltages at the station, as read from the pressure wire, particularly at first, when the pressure wires which were installed to come in from the center of distribution, consisted of small iron wires which were arranged on knobs placed immediately below the feeder wire to which it corresponded. The inductive effects that were observed in these pressure wires were exceptionally great. In fact, a pressure wire which would indicate that at the center of distribution the voltage was, say 115, the voltage might be either 150 or it might be 95—simply due to the effect of the neighboring wires. It was, therefore found that this arrangement of pressure wires was absolutely worthless for indicating the center of distribution pressure at the station. Four wire cables were then adopted in place of the iron wires, and then we were able to know what pressures we had at the centers of distribution. After these were installed, and the load kept increasing, our troubles began to multiply rapidly. They increased it seemed, as the square of the

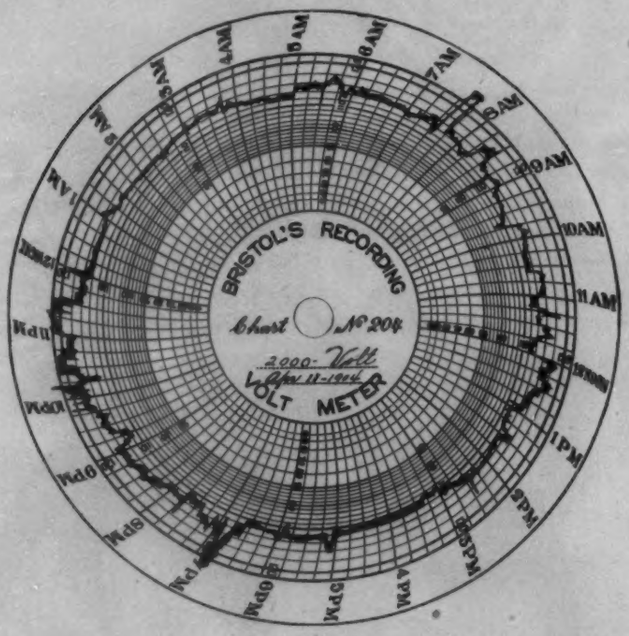


FIGURE 1

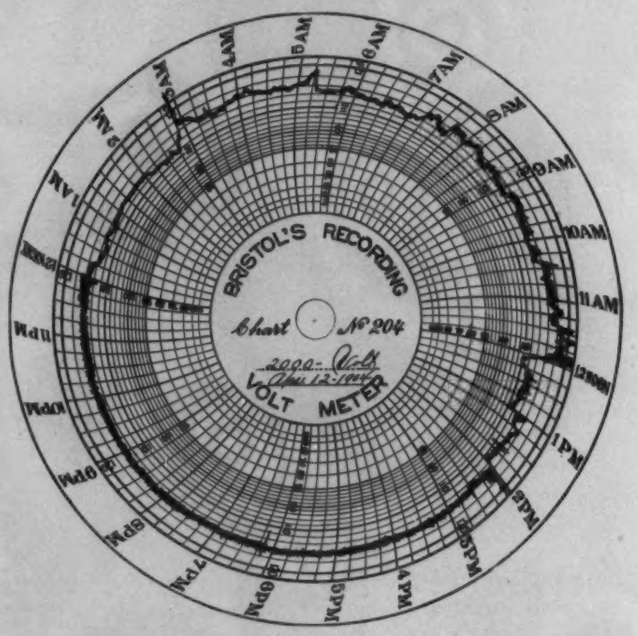


FIGURE 2

*A paper presented to the Eighth Annual Convention of the Pacific Coast Electric Transmission Association, Monterey, California, June 21-22, 1904.

load kept on increasing, our troubles began to multiply wires by transposing the circuits, and instead of having the A wires running straight up and down the pole, and the B's next to them, and the C's following, the A wires were arranged diagonally across the pole, and then the B and C. In that way we got rid of some of the unbalanced voltages, enough in fact, so that we were able to run the load on the network up to something like 6000 lights; but at the same time the results were still unsatisfactory, and it has been finally decided to feed the network with a system of banked transformers which we are now installing. I want to show you about what the drop in one of these feeders was, compared with how they could be calculated. Taking a 4-0 wire, carrying 86 amperes, 2000 feet, it figured out that the total drop in that line, including the resistance drop and the reactive drop, calculating, was about 42 volts, and this same drop

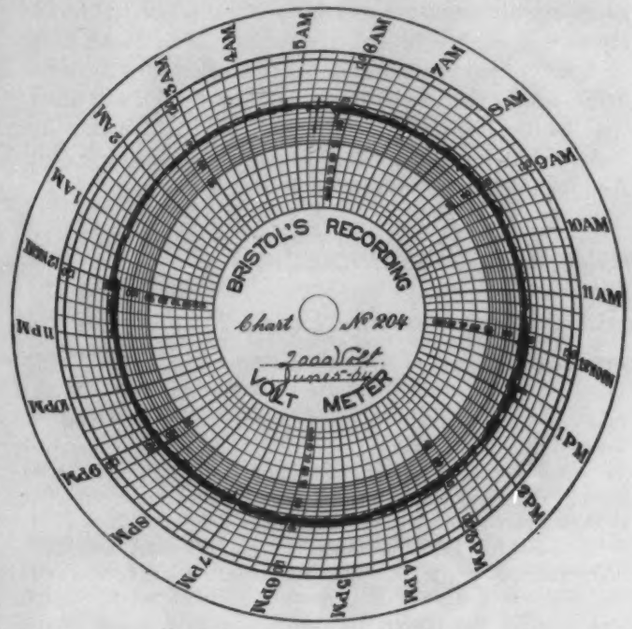


FIGURE 3

being measured, was found to be actually 44 volts as near as we could tell. After changing this and adopting the transformer method, we were able to obtain these charts, (showing). This chart, Figure 1, which is quite irregular, represents our station voltage at the sub-station before any changes were made. We installed what is known as an I R T automatic compensated voltage regulator, having a capacity of 200 kilowatts, which gives us a range of about 480 volts up, and 480 down, carrying 250 amperes. This chart, Figure 2, was taken the day that regulator was put in operation, and shows the station voltage. You can see here very readily the hour it was connected. This chart, Figure 3, shows the voltage we are now getting, as recorded on a recording volt-meter which is tapped on to one of the pressure wire cables indicating the voltage at the center of distribution, showing that we have about solved the problem of regulation. This chart, Figure 4, was taken right at the regulator.

I might mention another queer thing that I found. We put a bank of transformers in a large department store. We had to run a lead of about 130 feet of four 500,000 circular mil. cables. These were placed about three inches apart, the neutral being on the outside, followed by A, B and C. The distance between the neutral and C being the greater, it was found that on Saturday nights they began to complain about their voltage. I measured the voltage at the transformers, both from the neutral to the outer wires, and between the outers. The triangle seemed to be perfect. I went to the switchboard, about 130 feet away, and with the load approximately balanced there was about six volts more drop between the neutral and C than between the neutral and either A or B. It did not appear to me that I could account for that as being inductive drop, and as we had installed temporarily some watt-meters in the line, and it was necessary to make some temporary splices, the first thing that

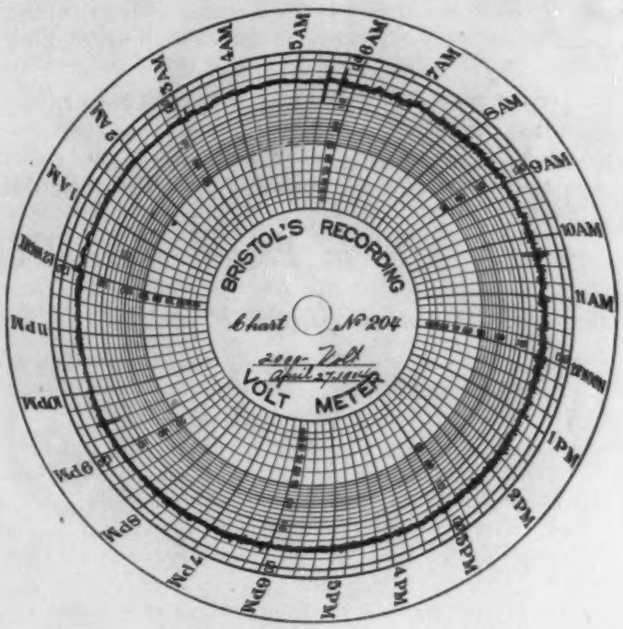


FIGURE 4

struck us was that this temporary splice was not well made, and perhaps the heating was the cause of the drop. We went there and everything was perfectly cool, and the idea then struck us that perhaps it was inductive drop. Without taking the time to figure it out, I simply unloosened the neutral wire from its fastening and dropped it down, and hung it immediately underneath the middle wire of the remaining three. This immediately acted like a regulator and the six volts disappeared.

Another peculiar thing I noticed, was that if this neutral was swung over further and put underneath the wire, showing the drop of six volts, this drop again appeared. This I have not had time to figure out. I just noticed that the other day. The effects are there, however, and it goes to show that in carrying very heavy currents at a low voltage; where alternating currents are used, great care must be exercised if you want to have equal voltages, to get the wires properly arranged so as to get rid of the unequal voltages.

A PLEA FOR AN AUTHENTIC HISTORY.*

BY GEO. P. LOW.

AT the outset let me say that it is not the purport of this brief paper to ask if old acquaintance should be forgot by its writer, as the title might be construed to indicate. Depend upon it that he will not forget, not in the least. But posterity will forget unless the works of that grand army of pioneers, who have made the electrical industry of the Pacific Coast what it is, be preserved in permanent form. To accomplish this is just why the suggestion contained in these lines is commended to your favorable action.

In this busy day we are far too apt to think of the past only in the light of its bearing upon present needs or future hopes. Commercialism, industrialism—mammonism, if you please—prevail in every artery and vein of business life. Would not it be well to pause in the struggle for wealth for the moment that would be necessary to record the history of the electrical industry of the Coast while it is yet possible to do so with painstaking authenticity? Electrical engineering is the creation of the present generation; then may not the present generation best chronicle it, or shall the task be vaguely left to the indefinite future, when he who will may glean from the musty files of sundry periodicals, from the here and there of fragmentary letters, from the hot-houses of corporate records, and from the vagaries of multi-mouthed tradition?

As true as it is that man is known by his works, so true is it that man hopes that his works will be known to coming generations. Along with other virtues, each of our breasts harbors an ambition to leave a good name to posterity—an ambition that, cardinal in its right, is closely related to love of home and country—to paternity and patriotism. Let us cultivate this ambition and bring it to a material form; let us chronicle all that has been done on our chosen field, and chronicle it faithfully and well; let this worthy Association, solely representative as it is in a vast domain, appoint an historian with whom it will be a labor of love to collect and collate, to systematize and perfect, every possible record that becomes necessary to complete the history of the electrical industry of this mighty West. Let us do it as an Association, each individual contributing his best effort to the cause. Thus can we revive and perpetuate that which will otherwise be lost forever, and in so doing we will make, not history, but an authentic and invaluable chronicle of it. And for this labor, posterity will ever thank us.

In Eighth Annual Convention Assembled.

Being a Complete Unofficial Report of the Discussions Held Upon the Papers Read Before the Monterey Convention.

MONTEREY, CAL., TUESDAY, JUNE 21, 1904.

In the absence of the President, Mr. H. H. Noble, and the Vice-President, Mr. H. H. Sinclair, Mr. C. H. Pennoyer was called upon to take the chair. He spoke as follows:

THE CHAIRMAN—I have the honor of introducing to you the Honorable R. F. Johnson, Mayor of Monterey, who, I am sure, will make you feel at home.

(Mr. Johnson then delivered the address of welcome appearing in THE JOURNAL for July, page 189.)

THE CHAIRMAN—I take pleasure in introducing to you R. H. Willey, who will tell you something of historical Monterey.

MR. WILLEY—Monterey has an interesting past, and, thank God, it has a fine prospect for a prosperous future. And the science which you represent and the questions which you will discuss while assembled here among us will perhaps influence our growth more than anything else.

This town has a beautiful location. Nature has embellished it with beautiful scenery and picturesque landscape that is not surpassed in any part of the world. And with a wide-awake and energetic head in our city affairs, in our present mayor, R. F. Johnson, and the influence which this convention will bring we propose to do a great deal for our city and to grow and progress in municipal affairs more than ever before.

We have here a climate unequaled for health, where life can be one round of sunshine and pleasure; we have glass-bottomed boats, through which you can view finer pictures than artist ever painted, submarine views which no imagination can fully portray. I can not promise to show you the Russian submarine navy; for though she has a submarine navy it is not here. We have salmon and all other kinds of fishing, and every character of enjoyment any one could wish, to their heart's content and their soul's delight.

But what has kept this town back? This most delightful, historical spot in the State of California. It has been awaiting the torch of the magician's (electric) wand, which will produce the power, the force, the energy and transform lethargy into life and activity. Here is one of the finest harbors on the Pacific Coast smiling at our door, and upon its calm, peaceful waters there should be ships from all ports in the world with merchandise and goods from every country and every climate on the face of the earth. The opportunities to make this a great city are here, the possibilities are not lacking to make this a manufacturing center. We have the road-bed already graded on the grand Pacific Ocean for traffic all over the world, but we need rolling stock, wharves, harbor improvements and ships to carry merchandise. We have now men of energy, push and enterprise, who have petitioned the city fathers for the privilege to make great improvements, and the city, with much wisdom, has granted their request, and in the near future we may hope to see business increase and the town grow with new life and vigor.

Heretofore California has lacked but one thing to make her one of the most advanced States in the Union, and that is the "power" or the means to produce the power for the economical, commercial prosecution of manufacturing industries. Our coal mines have been so limited that it has been properly said the best coal mines we possessed were vessels traversing the ocean bringing coal from Australia. Now,

*A paper presented to the Eighth Annual Convention of the Pacific Coast Electric Transmission Association, Monterey, California, June 21-22, 1904.

however, that great energy which you gentlemen are dealing with, our wonderful resources, hitherto viewed from a picturesque standpoint, yet pregnant with latent energy, will give to us a more economical power than could be obtained were Pennsylvania's coal fields at our immediate hand. I have reference to lakes situated at high altitudes, the gurgling brooks and mountain torrents in which, from time immemorial, have lain dormant the energies required to produce a manufacturing mercantile center.

Within easy reach of this city we have immense water storage capacity and ever living mountain streams sufficient to generate electrical power which may and will convert this city from the old "Sleepy Hollow," which it has so long been, to a bright, wide-awake and up-to-date manufacturing, commercial center. As I have before said, we have a magnificent harbor of magnitude and protection sufficient for the entire fleets of the world, we have a climate which permits of the longest hours of work, we have the natural advantages of sanitation, and in fact we have everything, save that which we expect and know the gentlemen engaged in your profession will give us—that energy which will make of this, the old capital of California, a manufacturing and commercial center.

THE CHAIRMAN—I will now introduce to you General William Quinton, and as the General had approximately forty-one years' experience in the service of Uncle Sam, I have no hesitancy in leaving him to the tender mercies of even the Transmission Association.

General Quinton delivered the following address:

GENERAL QUINTON—As president of the Chamber of Commerce I have been requested to welcome you to Monterey. This is a most pleasant duty to perform, and I regard it as a great honor to greet as intelligent a body of gentlemen as that I find assembled here to-day; to extend the right hand of fellowship, and, with the extension of that hand, to assure every member of your organization that our hearts, energies and best impulses accompanies the friendly grasp, and that—if we fail to make of your visit a pleasant memory—that failure will not be through lack of effort or intensity of purpose upon our part. We desire you to feel at home. You come to us from every part of this great State, and, for this reason, had we no other in view, we desire you to carry back, when you do return, a pleasant impression of this municipality. Hence, in pursuance of this general idea, everything that we have to offer in this section of country is wide open to your inspection, and the motives that dictate that offer come straight from our hearts and are as broadly wide and generous as the bay that makes this historic old town conspicuous. Unfortunately for us, that bay to which I have alluded is not yet exploited. Pity 'tis, 'tis true. Yet the bald fact is undeniable that Monterey Bay is almost as dead to-day—in so far as commerce is concerned, as it was when the first settlement was made upon its shore line. Look for yourselves, gentlemen, and you will observe that it is a lovely sheet of water—approachable and safe in all kinds of weather—aside from being one of the three ports on the California coast that can make this boast of perfect security—San Francisco to the north and San Diego to the south of Monterey being the remaining two that I have referred to. Yet few keels plow the waters of Monterey Bay. Its quiet is majestically serene and unruffled. Its Custom-House, which, in the early part of this century was the *only* one upon this coast, and at which every vessel engaged in trade upon the Pacific Coast was obliged to enter its cargo, is now a relic and is curiously viewed by tourists who give it about the same degree of interest that they would bestow upon the stony eyes of the Sphynx—were they traveling in Egypt. The speaking quiet that I have attempted to describe does not, however, strike the average energetic, restless American population that people the shore line to-day as being quite the correct idea in this age of struggle for commercial supremacy, and they are reaching out and looking for opportunities to improve the situation, so as to keep in step with that which we term modern civilization. Classing myself with the eager and discontented throng occasionally I give wings to my imagination and weave dreams for the future—and these dreams are far beyond the boundary lines of avarice. I picture the lovely hills that surround this beautiful harbor covered with homes, the flats with warehouses and factories, and the harbor filled with white-winged messengers of commerce loading and discharging cargoes from every quarter of the civilized globe. so vivid are some of the dreams that I invoke that, at times, it seems to me that I can hear the hum of industries being prosecuted and my mental vision farther notes long lines of handsome business blocks lining splendidly paved streets, backed up by palatial residences, the free, luxurious homes of a well-to-do, prosperous, industrious and contented population. Nature has done everything that she could do for us. She has endowed us with an unsurpassed climate. She has endowed us with the richest site in the United States, as also a soil that will produce anything under heaven that will grow anywhere else, and that, too, with a minimum sum of labor. Aside from this, she has endowed us with a wealth of other resources that I have not time enough to enumerate. All that I can say is that the opportunity here is wide open to any man who has the courage to seize the passing chance. Is my dream an idle one? Is it but a figment of my imagination and born of a hope? I think not. Already I can see in the East a ray that betokens the coming of a new day. We have indications of a change, and I note progress with the square of advancing months, and, as I note, I sigh for the gift of eloquence, a more fertile mind and a smoother tongue to express my thoughts. I ask you gentlemen, while you are here, to look for yourselves and inspect this broad and beautiful harbor of ours, and then, following the inspection that I suggest, reflect upon its possibilities in these days of feverish competitions in business life. You will note, and that, too, at a glance—that it requires no skilled pilot to conduct a vessel to a safe anchorage by feeling his way through tortuous channels cut up by baffling counter currents. You will note, further, that the bay offers every inducement and every facility for development—in that it has a rich agricultural country behind it, capable of supporting millions of people. Note, further, that Monterey Harbor is the natural outlet of the great San Joaquin Valley, the richest valley in the world and that valley lies only one hundred miles distant. Note also that Fresno County, that possesses the largest known iron deposit upon the face of this earth—the celebrated Minurett vein—has its natural outlet upon Monterey Bay. You will wonder, doubtless, why it is that this mine that I speak of and the country surrounding it is as yet practically unexplored. Why is it that the resources of Fresno have not been exploited and its products brought to market. That county has yet to meet the man who will herald to the world the result of his investigations in such a manner as to interest capital in a process of development. Note, also, please, that Monterey is the natural outlet of the Lower Santa Clara, the San Juan Valley, and the great Salinas Valley—the latter being only sixteen miles distant from Monterey. The Salinas Valley fosters in its bosom the largest sugar mill in the world. Note also that Monterey has a wealth of timber and minerals—a lovely climate—unsurpassed drainage, as also the purest water upon the face of this green earth, and that, too, at such an elevation as to generate power enough to meet the demands of a population many million times greater than that which we to-day have. Note also that arrangements have been made to supply Monterey with cheap fuel—mineral

oil—to be piped from Coalinga. You all know what cheap fuel means in the line of opening up industries, for the smelting of iron, manufacture of glass and many other lines that I have not time to enumerate. The opening of the oil industry is the first step taken to wake the old town from its slumber—a slumber that ranges over a period greater than a century. The old town has been in a state of dormancy long enough. That which we desire is an intelligent and industrious emigration—people who will settle among us and aid us in the development of the resources at our disposal, and I request you to announce that fact to the world. I also ask you to inquire into, mark and note the matters to which I have referred, feeling confident, as I do, that you will intelligently consider and digest the subjects. The reveille and assembly will sound for Monterey in the near future, to which we will all cheerfully respond and wheel into modern progressive lines. We have learned "to labor and to wait," and we are waiting now, with feelings of perfect confidence, the fortune that the future has in store for us.

THE CHAIRMAN—I am sorry there is an absence to-day among our number of the regular supply of spell-binders, so I will take it upon myself to offer the thanks of the Association to the Honorable Mayor and the gentlemen of Monterey for their splendid welcome and for the entertainments that they have planned for us. We must not forget also to thank you and the ladies of Monterey, on behalf of our ladies who are with us, for the entertainments that have been planned for their benefit. I know that all of the members and their ladies will go away from Monterey with kind thoughts and with thanks in their hearts for the entertainment afforded them by you both. The secretary will call the roll.

THE SECRETARY—There is a quorum present, Mr. Chairman.

THE CHAIRMAN—There being a quorum present, I will declare the Eighth Annual Convention of the Pacific Coast Electric Transmission Association open. The first business will be the reading of a paper by Mr. A. M. Hunt, entitled, "A Proposed Method of Determining Meter Rates for the Sale of Current, with an Example from Data of a Large Steam-Driven Plant."

The secretary then read the following paper:*

THE CHAIRMAN—There seems to be quite a diversity of opinion regarding methods of charging for electric current, which fact is shown by the various schedules that appear upon contracts and upon the backs of bills of the different companies throughout the United States. I would like to hear from some of the members in regard to this matter. Perhaps Mr. Holberton can enlighten us. He has had some experience in that line in Oakland.

MR. GEORGE C. HOLBERTON—I have not had a great deal of experience in any particular case of that kind, but I see no reason why it would not work out. There are a number of similar arrangements—for instance, the Wright demand system—that sound very well on paper and look all right theoretically, but which are hard in practice. It takes a whole lot of talk to a consumer to make him understand. The majority of consumers prefer some kind of a straight rate, even if it is a little higher in the end. For instance, a man starting out with a 10-cent base rate, and having a consumption which would entitle him to average down as low as 6 cents, would say, "Well, give me a 7-cent rate straight." They don't seem to like any sort of a sliding scale proposition. That has been my experience.

MR. C. W. HUTTON—This article by Mr. Hunt is a subject that in order to understand thoroughly needs considerable time to be analyzed. I have not had the time to do that in this case. It seems to me, though, that on general principles the idea is very good. There is one point that Mr. Hunt makes, where he states, "It does not take cognizance of one important factor, viz.: the portion of the twenty-four hours during which use is made of the current, and the time at which the peak occurs."

There are some methods in use that do that, one of which I think was brought out a good many years ago, when Wilmerding, of the Chicago Edison Company, devised a curve that took cognizance of that fact, and the curves which I used in my paper were practically copies of his chart, but that does not take cognizance of hours that each consumer uses. I have not had time to analyze this method of Mr. Hunt's, but at first sight it seems to me that it does, on account of its curve being simply a straight line, plotted on logarithmic paper. I don't see why it would not take cognizance of it—that is, if you vary the rate for the different number of hours' consumption. It would seem to me that it would.

MR. CLEM A. COPELAND—A couple of years ago, when I became identified with The Edison Electric Company of Los Angeles, we had what we called the jumping rate—so many kilowatt-hours 14 cents and so many other kilowatt-hours 13 cents, and jumping down in the different consumptions by 1 cent. If you draw that in a curve you will find that it makes a curve approximately like a pair of stairs, and it struck me that some such curve as Mr. Hunt's figure 2 would be a good scheme of charging. I proposed this to my company, but I was not accepted on account of being too complicated. It was not based, of course, on any mathematical analysis such as this it, but was sumply a curve which was to follow the pair-of-stairs curve that was then in vogue. This rate of charging was such that if a customer during certain months had used a little more current than he usually did, he would pay less for the month for his power than he actually used. Of course that is unjust to the company, and always makes a lot of adjustment and unnecessary work with his bill. I find, however, that it is almost impossible to introduce any refinements into a rapidly growing community, and it seems that we have to wait several years for any such refinement as this. At least, I find it so in the southern part of the State. Consumers seem to want something very simple.

MR. W. G. CLARK—I have had some experience in rates to consumers; in fact, I am having some experience now, being an officer of a lighting and power company. This plan suggested by Mr. Hunt seems to me to have the objection that one meets with most often in the matter of rates charged to the consumer. I find that most of the complaints come from the consumer in the summer time. He will come in and complain that he is only burning one 16-candle power lamp in the month, and yet his bill is three dollars, just the same as it was when he burned a number of 16-candle power lamps in the winter time. Under this arrangement the rate runs up very rapidly, as the total number of watts consumed runs down, so there is a great deal of difference in his bill. It strikes me that a scheme which would average that up a little better in making a little lower rate when the consumption is smaller in the summer time, and a somewhat higher rate when the consumption is large in the winter, would be a good one. I don't mean that literally, but I think it would be a good idea to give the customer a difference in the rate.

One gentleman spoke of the fact that a customer wanted to know just what his rate was. I find from experience that they much prefer a flat rate. Tell a man that his light is going to cost him six dollars a month and he is pretty well satisfied. He would rather pay a little bit more on a flat rate than he would under a sliding scale that he is not familiar with. A plan that I have adopted in the plant that I am

*THE JOURNAL, June, 1904, page 190.

connected with now is to take the number of lights that the customer will require or is wired for, and charge him on a basis of two-thirds of the number of lights connected. If he will guarantee the company 50 cents per month for each of those lights, he gets the minimum rate, and if he guarantees 25 cents per month he gets the higher rate. It goes down to 10 cents. If he guarantees ten cents a month on his lamps he gets a maximum rate per kilowatt. That is merely an outline of the system. I have had it in operation about five months, and so far it has worked out more satisfactorily than any other system yet devised. So far it has worked out very nicely.

THE CHAIRMAN—Mr. Cory could probably tell us something in regard to Mr. Hunt's paper.

PROF. C. L. CORY—In reference to what has been said, I happen to know that the origin of this paper came at a time when the board of supervisors in San Francisco were making their annual investigation preparatory to fixing rates. The prime cause of the investigation then undertaken by Mr. Hunt was to convince the board of supervisors that an actually uniform rate for all consumers was not just. You all know, those of you who are interested in selling power, that an official investigation is carried out annually in San Francisco, and the rates are fixed at a certain sum—10 cents or something of that kind. The men investigating the system were sincere, undoubtedly, but they could not understand how the amount and the time of the peak load should affect the rate, and in investigating that matter, Mr. Hunt, I think, took up the work which resulted in the curves here drawn. I think this method of determining the rate is more to assist the power company in ascertaining what rate it should make, and then give a flat rate to the customer, rather than to have the rate changing from month to month. We all know that where a large amount of power is taken, a flat rate is desirable. You have a contract running a certain length of time, but it is convenient for the company furnishing the power to refer to just such curves as these, to find what kind of a customer it really has, and to fix the rate accordingly. If we don't do this, how much do we know?

For instance, we will take the plant here in Monterey—how much does that plant know about the character of load which is delivered, say, to the Hotel Del Monte, which takes part of its power? If you don't make some such investigation as this, you never learn the character of the load taken by the consumer, and these curves are available for that purpose. I remember quite well that the absolute application of these curves to particular customers, in fact, any customer, was found to be impossible, for the reason, as has very well been said by Mr. Clark and Mr. Hutton, and I think also Mr. Holberton, that what the customer wants is a definite fixed rate.

There is one point which may be a little foreign to this, but it is of interest, I think, to us. I happened, not long ago, to look into the question of how some meters were running. These were in the plant of a large milling company, whose bill was approximately $1000 a month. When I was asked to look into the whole matter of the meters as well as of the machinery, I was told immediately by the manager, who was a very intelligent man that his power bill was 40 per cent. more during the last few months immediately previous than it had been three or four months before, and the milling output had not been any greater. Of course, the only conclusion was that either they were using a great deal more power than they should use, or the meters were not running correctly. It happened to be a two-phase system, and there were two meters. When I came to look over the bills I found that instead of the cost of power being any greater per day, it was not, but it was entirely due to the fact that the company reading the meters had included in one reading 41 days, and in the other reading about 23 days, and this man, busy as he was, failed to notice the fact that his bill covered in the one case 41 days, and in the other case 23 days. I could not help being impressed with the desirability on the part of our companies, if possible, to read meters at equal intervals; and the very point brought out by Mr. Clark, that "My bill is much greater this month than it was last month, and I have only used such and such power, while the previous month I used what I thought to be more," and so on, is caused to a very large extent by the fact that the meter bills do not cover equal intervals of time. Of course, there are other things coming into the case—holidays, and so on—but the man purchasing power very seldom knows what a kilowatt hour really is. All he knows is that he is turning out a certain amount of material, and that his bill is a certain amount, and if his power bill increases 40 per cent., he thinks that the power company, either through the meters or in some other way, is not giving him the same kind of a deal which he had previous to that, and so an investigation begins; but just as soon as we look at it carefully we find that the situation is all right, just as it should be.

Going back to this paper, the question is, I think, of its direct application to indicate to the power company how the manager, or the man in charge, may investigate each individual customer from these curves, and then fix a rate which seems to be rational. We are too many times inclined to say that we can take on a large amount of all-night arc lighting, "because it does not cost anything." Each kilowatt bears a certain proportion to the cost of operation. If you assume, for instance, that your street lighting costs a very small amount because it fills up the load from midnight to morning, you are really charging up a part of this cost to some other period of the all-day load.

THE CHAIRMAN—If there is no further discussion, we will listen to the next paper by A. J. Bowie Jr., "Transmission of Power *versus* Shipment of Fuel."

(The Secretary reads the paper.*)

THE CHAIRMAN—You have heard the reading of the paper. Has anybody anything to say regarding it? I think we could hear from Mr. Baum in regard to this, as to the cost of installation as compared with waterpower transmission.

MR. F. G. BAUM—I don't think I am prepared to give exactly parallel cases, because I have not thought the thing out on that line.

THE CHAIRMAN—Is there any other discussion?

MR. A. H. BABCOCK—It will seem to me to be too bad if this paper is allowed to go without discussion. The matter is highly important from the several standpoints.

THE CHAIRMAN—We should like to hear from you.

MR. BABCOCK—In view of the fact that this is a transmission association, and here is a practical and direct attack upon long distance transmission, it would seem to me highly significant if it were allowed to pass without discussion. It would be interesting if we could get some figures on the other side. It would be interesting, for example, to know on what basis this cost of power is calculated. I have made some very hasty figures here which would indicate that the reciprocating engine had been considered in this matter. If turbines were used, there is a possibility that this price might be still further reduced. I hope somebody who is posted on the turbine question and on the transmission question will say something.

THE CHAIRMAN—The manufacturers of turbines are claim-

*THE JOURNAL, July, 1903, page 193

ing a higher efficiency for the turbine, and a less consumption of fuel, than for a good reciprocating engine.

MR. J. A. LIGHTHIPE—I think both the Parsons turbine and the Curtis turbine claim a higher efficiency. It is very hard to get any accurate data as yet, but the plants we now have running show a decided improvement over the fuel economy, even with the highest class of reciprocating engine. I am not prepared to give any definite data in regard to the economy, because we have not got it. The plants are being installed just as rapidly as possible, but as a rule, as soon as the turbine is ready to turn over, the load is ready for it. I think the 2000-kilowatt turbine at Los Angeles has been running two months, and I feel perfectly sure that we have not had one minute's time to make any fuel test on it. Mr. Copeland of Los Angeles is here, and I think he can bear me out, that that turbine has not had any time to rest since it started. The Phoenix, Arizona, turbine, which is the second turbine we installed on the Coast—500 kilowatts—we turned over just the minute we possibly could, to help out the peak load, as the water at Phoenix is at very low ebb at this time of the year. They have had very few rains. That is a Curtis turbine running in conjunction with a little De Laval turbine, and also with the water power, and we have to run it without any governor as yet. On the Coast here, we have not had time to make any thorough test on the steam economy, but what tests we have made have shown remarkable economy.

THE CHAIRMAN—Why I asked that question was that a certain agent for a well-known engine sent out pamphlets and circulars and information giving comparative tests of steam turbines, and their own make of reciprocating engines, in which the reciprocating engine showed a decided advantage in the matter of economy over the turbine.

MR. LIGHTHIPE—I can't give you any accurate data. Mr. Krusi, our turbine expert, who was out on the Coast this winter, stated that the economy of the Curtis turbine in the Fifth Street Station in Chicago was about one pound of Illinois screenings better than the Harrison Street Station, which contains a reciprocating engine; one pound of screenings per kilowatt hour.

MR. W. W. BRIGGS—The question of desirability of turbine installations must not be confined to the steam consumption only. The turbine will change these figures materially in the cost of power house, depreciation and maintenance, as well as in steam economies, themselves. A few makes of extremely high-grade reciprocating engines and the turbines reach very nearly the same point in economy at maximum load; but the station that operates at 100 per cent. load factor is rare, and the high economies of the turbine at the lower loads are very appreciable. I have a test that I intended to bring here, but I have so few of them that I was afraid that some might feel slighted if I did not have one for everybody, and did not bring it; but if it is interesting I would be glad to have it here to-morrow. It is a set of four tests that were made by disinterested parties, where the data is absolute and made under direct running conditions and not in the shop. The point should be borne in mind that the power house cost, maintenance and consumption of oil are all points in favor of the turbine.

MR. LIGHTHIPE—Mr. Copeland can tell us something in regard to the operation of the turbine in Los Angeles.

MR. COPELAND—Just as Mr. Lighthipe said, we have had no time to make any accurate test, except an overload test. They have the steam turbine in the power house. We have been able to run it at a very high overload, and that is all I can say about it at present. Steam has been up, and it has been in service all the time, and we have hard work keeping up with the load. We are going to strive to make very accurate tests.

MR. BAUM—I think that in order to get at this we should eliminate those expenses which are the same, whichever end of the line the power house is assumed to be put. For instance, assume that we have a steam plant; whether it is put at the center of distribution, or in the oil fields, it can be put in at the same price. You have your railroad at your oil fields and at center of distribution. Whether it is a steam turbine, or steam engine, or whatever it is, you can put in your power plant at the same price at either place. Therefore, in considering the difference between the two plants we must consider on the one hand the interest and fixed charges on your transmission line as against the increased cost of fuel due to hauling in the other case. That is the only distinction. I am assuming a steam plant in either case. The interest and the depreciation and the fixed charges against the transmission line he gives here at $6.90 per kilowatt per year. He says:

"Assuming 75 per cent. load factor and 90 per cent. power factor, the cost per kilowatt-year is as follows:

"Fuel (allowing for decreased efficiency), $7.50; cost of fuel oil at 15 cents per barrel, 43.3 barrels, per kilowatt-year, $6.50."

There is very little difference there. It will depend on the individual case whether we shall transmit, or whether we shall generate at the center of distribution; that is, whether we shall transmit electricity over wires or oil in cars.

The question of water power transmission was not brought in here at all, and I don't think it is necessary to bring in that parallel case. We might, however, make some comparison briefly, and we can take it in exactly the same way he has given here: "Total cost of steam and electric plant erected, complete without transformers, $684,000, or $76 per kilowatt."

We generally strive for a sum under that. That is, the power house, the water system, to be ready to deliver power to the lines, should not cost over $75 per kilowatt, if you are going to make any money in this country. There are a great many plants that have been put in that cost more than that; in fact 90% of them cost more than that. In some cases you can spend $200 per kilowatt, or $300. There may be one or two instances where there was more than that spent. But as a regular business proposition, we try to not look at anything that will not deliver power to the line at over $75 per kilowatt. On that basis the figures would compare just the same as the figures given here.

THE CHAIRMAN—It resolves itself into a question——

MR. BAUM—Of whether it is cheaper to transmit by transmission lines as against the cost of delivery of the fuel or power in cars.

MR. LIGHTHIPE—Except your fuel was eliminated.

MR. BRIGGS—It seems to me we have a shining example of this in California. We have a very large transmission; these lines cover a very great territory and reach inaccessible points, and they also reach the bay shore line, where a man using oil for fuel would have water transportation, which would certainly be in his favor. The fact that this transmission company with its immense lines and the development costs that pertain, owing to their gradual growth, are furnishing power where oil fuel is in use, at favorable rates and at the same time paying dividends, tends to show that the transmission man has not got the worst of it yet, in competition with fuel oil.

MR. LIGHTHIPE—The great point is the size of the units. You take Bakersfield, which has probably the cheapest oil in the State; the Power Development Company of Bakersfield is selling power throughout the cities of Bakersfield and Kern, and I think they have just signed a contract with the Southern Pacific Railroad Company to furnish power for

motors in their shops at Bakersfield. This is figured out, evidently, by the railroad company as being cheaper than oil, right at Bakersfield.

THE CHAIRMAN—At what price?

MR. LIGHTHIPE—I don't know what price of oil the railroad figured there. It is cheap at that point. But the main point in a comparison is, I think, the size of the units. If the amount of power used is small, it is probably a good deal cheaper to install motors, where they only have to have a foreman and engineer, and they can have any ordinary man around the shop to start and stop the motors. Practically, oil fuel is not used in Bakersfield at all except for making gas. The pumping plants, which are the main load of the Bakersfield company, are still all electric. There has been no talk yet of a steam auxiliary, although I should think a steam auxiliary at Bakersfield would pay very well.

MR. CLARK—I can't understand this paper thoroughly. He states here: "The annual cost of the pole line per kilowatt of power house installation is $6.90." I take that $6.90 as the cost of transmitting one kilowatt of power for one year over this line, as he figures it out here. If you put against that the cost of transmitting 43.3 barrels of oil to the city where the generating plant would be located at the center of distribution, and figure that at 26 cents a barrel, it figures up, according to my figures, $11.18. In one case he is carrying a kilowatt of oil to the center of distribution and burning it there, and in the other case he is saving his 26 cents a barrel for transportation, and burning his kilowatt of oil in the oil field, and paying $6.90 for getting that kilowatt to use over the line. It seems to me it figures out in the paper in favor of transmission.

THE CHAIRMAN—I think you have taken the cost of transporting the oil pretty low.

MR. CLARK—I take it at his minimum figure, 26 cents.

THE CHAIRMAN—I don't think we have ever been able to transport any oil for 26 cents a barrel.

MR. F. V. T. LEE—In the section of country around San Francisco the rate is 42 cents a barrel. That gives the power transmission man an advantage of about 30 per cent. to start with. If he happens to have any customers north of San Francisco, I think the rate is a little more. I don't think that will extend very far north of the line between San Francisco and Sacramento. I think the electric power man will always beat the oil man out, because in the first place he cuts down his item of attendance. All he employs is a motor, and possibly some transformers, and the power company builds the line. Around San Francisco, and north of there, unless we discover some new oil fields, or the Southern Pacific and the Santa Fe reduce their rate, the power transmission companies will be safe. The greatest trouble which the power transmission companies, particularly around the Bay of San Francisco, have had in selling power is to get the users of power to appreciate what it costs them to develop power. They count the number of barrels that go in, and they guess more or less on the amount of power that they are using, which is usually a very conservative guess, and from that they figure out what it costs them for the amount of oil. Then they get the kilowatt-hour rate and multiply it out, and the result is not always very satisfactory. If it were possible to get a fair comparison, I think that around the bay with the existing rate or where we might compete with water transportation, the power transmission company would be able to show a saving to the users, except with possibly in some of the largest concerns which have special facilities for transporting oil.

There is another interesting problem here that has not been touched, and it may be a real one with power transmission companies, and that is transporting oil by pipe line. I have no idea whether a pipe line and pumping station is cheaper than a power transmission line, but it would be a very interesting thing to investigate. If the oil can be pumped—and the Standard Oil Company claims it is doing it successfully—that might bring up another inquiry. I have heard some oil people state that the maintenance of a pipe line is very much less than the maintenance of a pole line. The trouble in getting expressions of that kind is that the pipe line man very seldom knows anything about the pole line, and *vice versa*. But I think that is the next thing that we will compete with, because in large quantities where the consumption justifies the installation, it ought to be cheaper than to haul the oil by freight.

MR. HOLBERTON—One thing you have overlooked in your expression, and that is, that you do not burn the same amount of oil at the center of distribution that you do at the oil field. You don't have to figure freight on the total amount you burn at the oil field. In making that comparison, they figure the same amount in both cases.

PROF. CORY—I think Mr. Baum has hit the nail on the head exactly. What he said was practically this: We are transmitting power, either in the shape of electricity, or in the shape of oil. We burn oil at 15 cents at the central station in Bakersfield, and we pay either 41 or 48 cents for the oil in the plant, 150 miles distant, wherever it may be. In the one case we pay 26 or 33 cents freight. In the other case we pay certain fixed charges on the transmission line. The difference in the transportation of power in the shape of oil, and the transportation of power in the shape of electricity is, as Mr. Baum indicated, the sole difference in the plant, and will differ in the two cases.

As far as the comparison of the generation of power by oil, and the generation of power by water power and transmission, this paper hardly brings that out. I have made some hasty figures here as to the amount of oil allowed for a given amount of electrical energy. I find that they are based practically on the figure of 1.6 pounds of oil per kilowatt-hour, which corresponds to the production of 200 kilowatt-hours on the switchboard per barrel of oil, which is, of course, quite good.

There is another point, too, as indicated in the paper, and that is that these two figures are based upon 100 per cent. load factor and also 75 per cent. load factor. We know perfectly well that day in and day out, all the year, we do not have any such load factor on even our best water power transmission plants. They may be delivering power to a large city, where the load fluctuates. It really comes down to this: When you have a transmission line you are not compelled to seek your customers—as we know very well that in the case of the lines coming to the bay—we do not alone seek the customers near Oakland and San Francisco, but we have in this case, 150 miles, and there is a demand for power in the entire district along the line. The ideal condition of affairs is, of course, illustrated by some of our largest transmission systems in the mining districts where dredgers are operated, where the load factor is pretty nearly 100 per cent., and located near the large water power transmission plants. Those lines are brought down to tide water, where oil may be purchased at a figure of, perhaps, from 75 cents to a dollar at the present time, and there we have the steam plant. The stations are connected, or tied together. Where the load fluctuates, where the load factor may be as low as 25 to 30 per cent., we are burning oil, and are only burning that amount of oil which is actually required by the load, and during such time as we do have the load.

Up in the mother lode district, and in the dredger district, we are running the large power transmission plants where

the load factor is nearly 100 per cent.

I think, to go back to the paper, that the point brought out by Mr. Baum is the essential one. Mr. Bowie has given a great many figures here; but the real essence of the thing is to take the difference which would exist in the two cases, and which indicates a very different conclusion from that which might be inferred by a hasty reading of the paper.

MR. CLARK—Taking up that point still further, I find that the difference, according to what he figures on, is a total of 14 per cent. Taking the cost of transporting a kilowatt at $6.90 and of transporting a kilowatt of oil at 100 per cent. load factor, at 26 cents, leaves $6.90 and $4.28. Now, assuming that they were to burn 14 per cent. less oil for generating at the center of distribution and that it would cost 14 per cent. less for carrying that fuel, it still leaves $2.71 in favor of generation at the source of fuel supply. That is, $2.71 in favor of transporting by wire, rather than by rail.

MR. BABCOCK—There is one point that has not been touched at all. To go briefly over the remarks made, Mr. Briggs stated that the fact that the companies are doing business shows that they can do it. This paper deals directly with a large unit; it deals with a 9000-kilowatt unit. It does not deal with the case that Mr. Lighthipe brought up, for example, the Southern Pacific shops at Bakersfield, or of the small consumers who want up to 200 or 300 horsepower. It does not touch them at all. They can undoubtedly buy their power cheaper from the power company than they can ever hope to make it. Mr. Lighthipe said he didn't know what price of oil was taken by the Southern Pacific Company in choosing whether they would use oil and generate their power at Bakersfield, or buy. In making such figures, the market price of oil is always taken. If it was not, we would simply be deceiving ourselves.

But there is one point that has not been touched at all, and that is the case of the large consumer—what he is going to do for reserve plant when the transmission line has trouble. Somebody has to put up that reserve plant. Either the power company must install, in which case the fixed charges and all of the operating cost of that plant must be charged up against the consumer, or the consumer, himself, must put in a steam plant or some kind of a reserve plant, in which case he carries his own fixed charges. The rate he pays is practically the same in either case. It is a question whether he shall carry the thing himself, and pay it once, or whether he shall let the power company carry it, and pay it twice. I would like to hear that point discussed, because it is one that I am up against, personally.

MR. LIGHTHIPE—Isn't it an actual fact that almost every transmission line of any extent has a steam auxiliary at the point of distribution?

MR. CORY—The place having the greatest advantage.

MR. LIGHTHIPE—Isn't the steam auxiliary at the point of distribution really the best storage battery that we can install? The steam engine that can take care of the peak load on 100 per cent. load factor is the most economical way a water power can run, especially in Southern California, where the water can not be stopped; it has to be used for irrigation after it goes through the wheel. Then the question of having the power at the center of distribution is an economical method of taking care of your peak load. It is also taking care of a chance of accident on your line, or a shut-down. I think all the large plants are depending more and more on steam auxiliaries at their point of distribution. Portland is putting in a large steam plant. When I was at Seattle about a month ago, one of those large McIntosh & Seymour engines was turning over night and day, ready for trouble. They got steam up, and although they had not been called upon to carry the peak, still they are ready at any moment to take care of the load in case of any failure of the long-distance transmission line. As to the comparison of the transmission line, between placing the power house at the oil fields or placing it at the center of distribution, I think they tie in together. I think every plant we have needs both of them. We need an oil supply at the center of distribution; we need something that can take hold of that load in case anything happens to our line, or ditches, or power house, and as our load gets heavier and heavier, the bugaboo on all our transmission lines is the peak load. It only lasts for two or three hours, and it is the heaviest part of our strain. A good, well-designed steam engine can take care of that peak load very economically. The two systems go hand in hand right straight through.

THE CHAIRMAN—Every plant which relies upon a transmission company should have a steam auxiliary, not alone for taking care of the peak, but as you say, for handling the load in cases of accident or shut-down, although in the condition in which the transmission lines are to-day, there are not many shut-downs or interruptions.

MR. LIGHTHIPE—Mr. W. R. Eckart made a suggestion that I think was very valuable: Take the large plant with a steam auxiliary, and then, in place of using a rapid-firing boiler, use the Scotch type, which carries a large amount of latent energy in the amount of water that it holds. This could have steam up all day long with practically a minimum of cost, and could be called on for a peak load of two or three hours without burning an excessive amount of fuel. Am I right, Mr. Hanscom?

MR. W. W. HANSCOM—Yes.

MR. LIGHTHIPE—I don't think that the question of thermal storage has been brought up at all. Whenever we install a steam plant, as a rule we install a boiler that is made for rapid firing, because we need it in a hurry; but the old Scotch boilers, which won't stand rapid firing, can still be run very economically for a long time, by reason of the immense amount of hot water that they contain. They could run for two or three hours, probably, very much more economically than a very high grade of tubular boiler could.

MR. BABCOCK—It seems to me Mr. Lighthipe has hit the point exactly. I don't see, in the case of a large consumer, how he can afford to maintain two steam plants. That is what it amounts to. I know that in one case of which I happen to have personal knowledge, it is more economical for the consumer to develop his own power by oil with a steam plant than it is to buy it from the power company. The actual station records show that. That is due, primarily, to the fact that the fixed charges on the steam plant have got to be paid, and also the station force has to be there ready, and their wages are going on. It is necessary to keep steam in the boiler, and you have all those charges to meet. So that in the long run it has proven to be of more economy to use the steam plant entirely.

MR. BRIGGS—In regard to one of those objections, in reference to keeping the engine turning over, that does not exist with the turbines.

THE CHAIRMAN—You must keep steam up.

MR. BABCOCK—You have to keep steam in your boilers. It is a good deal cheaper to use that steam and get something from it, than it is to waste it in radiating losses.

THE CHAIRMAN—In San Jose we have a steam plant capacity of about 1500 kilowatts, and we never have found it necessary to keep the engine turning over, or to keep steam up on more than one boiler, and it has been found more economical

for us, owing to the rate we receive, to take current from the transmission company than to operate the plant ourselves. While it does not cost us any more for fuel, perhaps, to operate our steam plant over the peak, yet if we had to operate it during the time of uneconomical operation, it would cost us more. Were we actually operating that steam plant day in and day out, the expense of operation would be more than the expense of the current taken from the transmission company.

MR. BAUM—In the great fight between the steam man on the one hand, and the power transmission man or the water man on the other, the steam men have one side of the case. They take it all steam. They consider that we have a particular affinity for water. So far as our corporation is concerned we generally put in water power because it is cheaper, but where a steam plant is the right thing we use that. The steam man is selling steam plants, and therefore he is all on one side; we are in the power business, buying power at a certain expense, and we, of course, try to make the cost of the power as low as possible, and therefore use steam or water as is most economical.

MR. LIGHTHIPE—I would like to ask if it is possible for us to get a definite idea of the cost of keeping steam up on a boiler, where the engine is not turning over. If that boiler is thoroughly protected, thoroughly covered, whether it is possible for us to get the actual cost in fuel of keeping that steam up as a reserve. Let that go in as one of the fixed charges, if you like.

MR. HANSCOM—It seems to me we are working away from the subject under discussion. Mr. Bowie has simply tried to show whether it would be cheaper to locate the generating plant at the source of supply of fuel, or at the center of distribution. In both cases, he has considered a steam plant, which seems to be the most reliable method of generating power that we know of to-day. It is only on water power plants that we have to have steam auxiliaries, and where they have a steam plant entirely, they do not have to have anything like the reserve plant that they would if they were depending on water. He has taken into consideration the fact that there is likely to be trouble with one of the transmission lines, and has provided two lines for that purpose, one of which, it is fair to assume, will always be in working condition. There is no question whatever as to the reliability of supply from the steam-generating plant, so in his case there would not be any necessity for having a steam auxiliary at the distributing station. The actual cost of keeping up steam in a boiler that was not delivering any work, I think, would be very low. You would have nothing to provide for except the radiation, and that can be reduced to a very low amount by proper protection of all the heated surfaces. There would be very little radiation of heat. The combustion would be so slow that there would not be much loss. You could keep a very low temperature in the stack, and the heat that would go up the stack would be practically nil; it would all be absorbed by the boiler. I don't think we need to consider a steam auxiliary at the center of distribution in Mr. Bowie's case at all. We would have a steam plant at either the source of fuel supply, or at the distributing station, whichever case happened to be the most economical.

THE CHAIRMAN—With the steam equipment at the oil fields, how would you take care of interruptions due to trouble in the line?

MR. HANSCOM—He has provided two lines for that purpose. He makes a note in his paper that the line would have to be sufficiently large to take care of the extra load in case one line happened to be out of order.

THE CHAIRMAN—Suppose both lines go out?

MR. HANSCOM—It may be that the plant would have to be located in a place where there would not be that possibility. The possibility of both lines getting out of order at one time is greater in a case depending on water than in one depending on steam, because you have climatic conditions, snow and other conditions, that you would not have in his case. It is not likely that oil would be found in the same place where you would get water supply. You have a mountainous country and snowstorms and atmospheric conditions that you would not have to deal with in a purely steam-generating plant.

THE CHAIRMAN—You think the element of uncertainty regarding frequency of snow or rain is greater than the element of uncertainty due to strikes or labor troubles or uncertainty of fuel supply?

MR. HANSCOM—You would have strikes and labor troubles in any case. I don't think you can consider that as being confined to any one case.

PROF. CORY—Speaking to what Mr. Hanscom has said, undoubtedly our discussion has gone away from the paper. I think that is the most valuable thing in these conventions. We have a paper on one subject, and we discuss something else. Replying to Mr. Lighthipe about the amount of radiation from the boiler, I can only say that in those tests that were made in Los Angeles it was determined about what per cent. of the lost heat was represented by radiation. The efficiency of those boilers at reading was in both cases a little over 80 per cent. The actual per cent. of heat that was lost by radiation at the time the boiler was doing its normal work was between two and a half and three per cent. Of course, the amount of radiation would be less than that during the time of keeping up steam only.

Mr. Babcock has brought up a point which we, really, as transmission men, have got to answer, and it has not been brought out in Mr. Bowie's paper, but I think, nevertheless, we ought to be ready to take up that very point. It is practically this: Suppose a customer—and I take it that Mr. Babcock has in mind some customer like a street railway system, or a big lighting plant that must have power under every circumstances—suppose they are in the market for two thousand horsepower, what will the transmission company say to them, and what will they say to the transmission company when they talk about putting in their own plant? Mr. Baum has pretty well answered that by saying that the transmission companies are doing both. It is true, as Mr. Babcock says, that this reserve steam plant must be installed. It depends upon conditions, as to who is to furnish that reserve steam plant. On the other hand, it has been said by Mr. Lighthipe that it is necessary to have a reserve steam plant at your center of distribution, and perhaps, have your engine turning over, and all that, which is perfectly true; but we can look at it from the other standpoint, from the standpoint of the man who thinks of putting in his steam plant. It is a very nice thing to have a transmission plant helping out and as an auxiliary to your steam plant. At the University of California, we are very small users of power, but I can assure you that although we have our own steam plant, and are compelled to have it for other purposes, such as experimental work, we are utilizing transmitted power constantly, and while we think of this transmitted power as being simply auxiliary to our own plant, and we keep off of the peak load, yet we are in the position of a buyer of power. We have our own steam plant, but at the same time we feel—in fact, I know absolutely from actual figures, that we are saving money by buying power at such times as we do not care about operating the plant. The transmission companies, in Utah, for instance, in and about Salt Lake, and the transmission companies in California, both north and south, it seems to

me are ready to say to the purchaser: "We will sell you power and give you continuous service. We don't guarantee that we will give you all the power from our mountain stream, but we will give you power. We will give it to you from our auxiliary steam plant; you can be sure you can get power. If you prefer to have your own plant, very good."

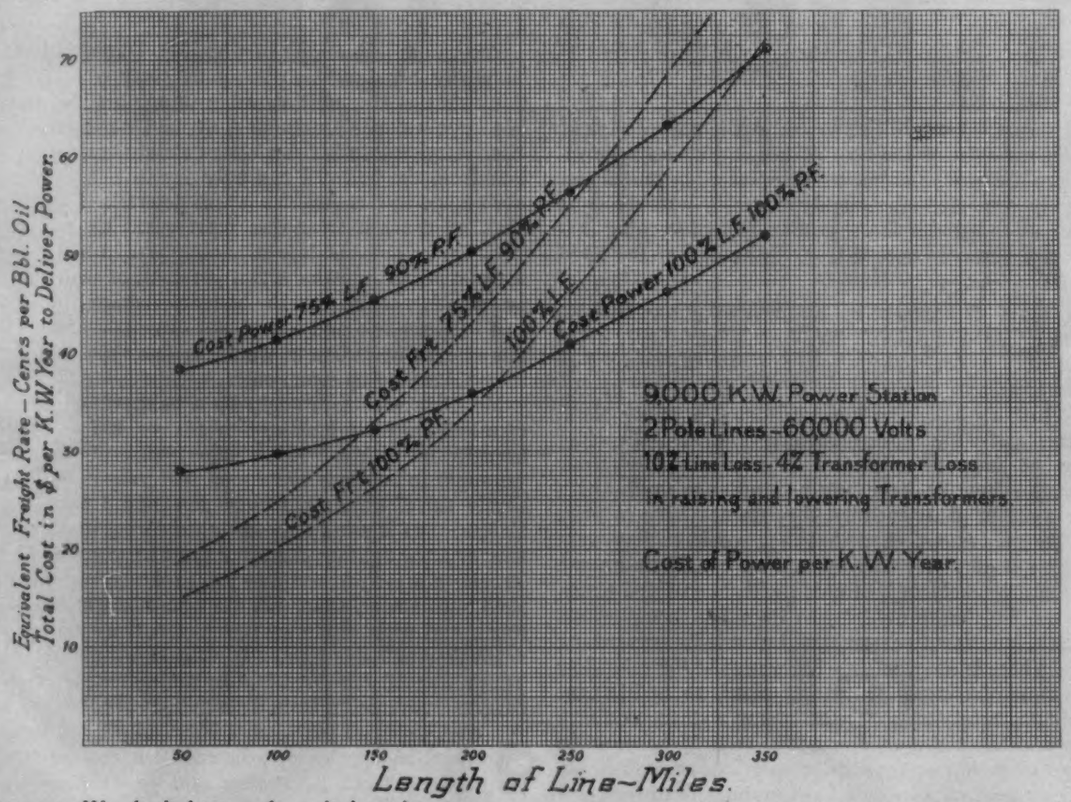
There is another point. While we have this auxiliary plant, consisting of storage batteries and engines, and all, this auxiliary plant is not alone for the big customer, but it is also of advantage to other customers. As you suggest, Mr. Chairman, in your own case; you could buy power cheaper than you can make it, and yet you use your steam engine. It seems to me, to come right down to it, the transmission companies, as we know them to-day—perhaps it was not true five or six years ago—are ready to say to the big purchaser of power: "We will give you power under any circumstances. We don't know where it is going to come from, but you are going to get it, and to get it sure."

MR. BABCOCK—I think Prof. Cory has answered the question and covered the ground very fully. It was exactly to get these points brought out, and to get the sentiment, I might say, of the convention, that I urged a discussion of this paper—possibly, more fully than some of the other members have been interested in. Prof. Cory has boiled the thing down to the least terms, and when the power companies can do as he says, the question between any consumer and a power company becomes simply, how much shall we pay. But we must be guaranteed a continuous supply of power. The North Shore Railroad, for instance, is a consumer of power. If anything happens to the transmission line, its trains come to a standstill suddenly, and there is a big growl from a whole trainload of passengers. It is not like a street railroad, where a person can get out of a car and call a cab, or walk, but there is a train filled with commuters, who demand a service on time, and the reserve must be there to do it.

(Communicated by the Author after adjournment.)

MR. AUG. J. BOWIE JR.—In the discussion of the paper it has been stated that in considering the relative merits of locating the power-house at the center of fuel supply or at the center of distribution, as the power-house is the same in both cases it can be eliminated as a factor of consideration, but in this statement the fact has evidently been overlooked that line and transformer losses will necessitate a decidedly larger power station for a transmission plant than for the other instance in which the power plant is located at the center of distribution. Hence there will be a considerably larger investment in addition to pole lines and transformers; and the increased cost of power transmission will consist of the expense of pole line per kilowatt received, the increased fixed and operating expenses to cover the necessarily larger power-house, as well as the increased fuel consumption.

For example, in the case of 100% power factor and 100% load factor, the annual cost of pole line operation per kilowatt of power-house installation is $6.90.



The annual cost of pole line per kilowatt received $= \frac{6.90}{.86} = \$8.02$

Increased fixed and operating expenses per kilowatt received—

$$= \left[\frac{1}{.86} - 1\right] \$14.50 = 2.35$$

Additional fuel to cover line loss, 7.1 gals at 15c— 1.07

Total $11.44

Which is the cost of *transmitting* power, pure and simple, under the most favorable conditions.

The power transmission was for a distance of 150 miles, and hence to assume that the same power could be transmitted to San Francisco from the Kern oil fields (over twice that distance) for the same cost would give far too low a cost of transmission.

The four curves show the cost per kilowatt of power delivered by the transmission line over various lengths of line, with 10% line loss and 4% loss in raising and lowering transformers, as well as the equivalent price which could be paid for freight on oil were the power-house located at the center of distribution. While the curves

are worked out on the above basis, the figures would of course not represent the most desirable proportions of line loss for various lengths of line.

Two cases of 100% power factor and 100% load factor, and also 75% load factor and 90% power factor, respectively, are given. The 75% power factor here, as in my paper, is meant to refer to the apparent kilowatt and not the real kilowatt. If referred to actual kilowatt, this would be equivalent to 67.5% power factor.

The curves given are all parabolas, and may be represented by the equation $K = A + BL + CL^2$

Where K = cost of power delivered.

A, B, C are constants.

L = length of pole line.

C depends on cost of wire, the cross section of which varies directly as the length of line.

B depends on cost of pole line and insulator as well as patrolling the line.

The line loss which gives the most economical transmission for 100% power factor and 100% load factor is as follows:

Length of Line.	Per Cent. Line Loss.	Cost per K. W. Year Delivered.	Equiv. Price frt. per Bbl.
150 miles	8.7	32.45	26.5c
300 miles	16.1	44.50	54.3

Compare these figures with the following:

Length of Line.	Per Cent. Line Loss.	Cost per K. W. Year Delivered.	Equiv. Price frt. per Bbl.
150 miles	10	32.48	26.5c
300 miles	10	46.40	58.7

SAN ANTONIO, TEXAS, July 23. 1904.

THE CHAIRMAN—The discussion has proved interesting and instructive, but we will have to bring it to a close and take up the paper by Mr. E. G. De Wald, "High Pressure Water Wheels, with Particular Reference to Girard and Francis Turbines." In the momentary absence of the secretary, I will ask Mr. Hutton to read it.

(Mr. C. W. Hutton reads the paper.*)

THE CHAIRMAN—You have heard Mr. De Wald's paper on the description of high pressure wheels. Are there any questions you would like to ask, or is there any discussion you would like to enter into?

MR. ROBERT MCF. DOBLE—In the absence of the cuts referred to in the paper, it is, of course, out of the question to attempt to analyze several of the important features mentioned therein. I hardly think that the writer intended to say that the power required to overcome the frictional resistance in the turbine was 50 per cent. of the power it would develop. I may not read that correctly. The author states:

"To express this important point more clearly, let us assume that it requires twenty cubic feet of water to balance the frictional resistance, that is, to bring the wheel up to its required speed; and again, that another twenty cubic feet of water will be sufficient to furnish the power required."

MR. LIGHTHIPE—With a big wheel and a small load on.

MR. DOBLE—In the absence of the cuts it is not practicable to discuss the points brought out in regard to the various types of runners and the arrangement of the gate. There is one point, of course, that is very much in favor of the turbine over the tangential wheel, and that is its possibilities for high speed. On the other hand it is generally considered that the point in favor of the tangential wheel is its simplicity. The usual type of turbine becomes less efficient as time goes on, because the wear which takes place diminishes the distance between the runners and the case, consequently, a certain amount of water goes through. It is regrettable that the author of the paper is not here, because he could explain a great many matters. Quite possibly, some of the gentlemen present have practical experience with these turbines, and I think it would be of value to hear from them.

*THE JOURNAL, August, 1904, page 233.

MR. R. W. VAN NORDEN—I think I can explain the point that Mr. Doble brings up in regard to the loss of power due to friction. We have an installation of these wheels, which is practically the first and only installation of any size that has been running on the Pacific Slope. Of course, the point that he makes as to the friction of the wheel is just simply the friction that any machine would have; that is, the friction of the generator bearing, and the windage of the armature and the water wheels. In our wheels there are eight chute openings, and I suppose it takes probably three-quarters of the first chute opening to bring the wheel up to speed. That would cover the loss of friction. As Mr. DeWald says, the curve rises after that point and approaches a flat curve. By the time you get, say, four chute openings, the efficiency of the wheel is very high, and the difference between half-gate and full-gate on efficiency curves is very slight.

There is another point that Mr. DeWald speaks of, namely, of its being possible to figure the efficiency of the wheel before the wheel is put in operation. This is true. The design of the bucket and of the chute is constant, no matter what the conditions are. If you take the impulse type wheel, you have a certain amount of experiment in order to get the highest point of efficiency, because you have always different conditions—different sized nozzles, different sized buckets, different diameters of wheel, and a great many other conditions. In this particular turbine you don't have any of those points to contend with. In fact, as long as you work to two lines, the relative and absolute lines of passage of the water, you design a curve to those points, and nothing else. It does not make any difference whether the wheel is large or small in diameter, you will get the same efficiency in either case.

The point that Mr. Doble makes regarding the wear between the wheel and the chute case will not, as a matter of fact, come into consideration either, because the wheel does not run close to the chute case; it could not run so; there must be an air space.

There is another matter that is not spoken of here, and that is the relative speed of the surface of the runner to the speed of the water. In the impulse wheel design, we generally figure that the speed should be practically one-half of the speed of the water— about 47 per cent. That is true in this wheel also; but as the runner runs close to the bucket and never changes the relative to the position of the stream or nozzle, you do not have the coefficient of discharge that you would from an open nozzle. In other words, instead of a coefficient of discharge of perhaps 94 per cent., you would only have a coefficient of perhaps 85 per cent., so that that would make the wheel a smaller wheel than otherwise it would be, if you use the type of impulse wheel.

THE CHAIRMAN—In the absence of the cuts and pictures spoken of in this paper, and the want of more time, I think we had better pass to the paper by Mr. Van Norden, "Ice Interference in Power Ditches at High Altitudes."

(Mr. Van Norden reads the paper.*)

THE CHAIBMAN—Are there any questions. If not, will Mr. Holberton read the "Report of the Committee on Standard Polyphase Distribution."

Report of Committee on Standard Conditions of Distribution:

Following the discussion at our last meeting of a paper on "Local Distribution of Transmitted Power," Mr. John Martin moved the appointment of a committee to report at this meeting recommending a standard condition for distribution, which committee was later appointed by the President.

The discussion immediately preceeding the suggestion of appointing a comm ttee was a very general one, so that it was a

*THE JOURNAL, July, 1904, page 194.

difficult thing for your commiitee to know just what to take hold of. As soon as your committee started to work they found that it would be necessary to confine themselves to a small portion of the subjects discussed, and they also found that it would be next to impossbile to lay down any fixed set of rules which would be approved by all of the committee, not so much through different views held by different members, but through the fact that almost every system represented entirely different conditions in the matter of details, which conditions had a very material effect upon the method of distribution. It was thought best, therefore, not to attempt to recommend any fixed set of conditions, but to take up certain matters discussed at the last meeting and collect data on those points to submit to you at this meeting. Your committe has therefore deviated somewhat from the original intention, and in place of submitting to you a long-winded report covering a multitude of different conditions from which each member would have to select the conditions best suited to his work, they have decided to present papers by the individual members covering a few of the subjects of vital interest in the matter of distribution; and it is hoped that these papers will bring out a discussion which will in the end prove far more valuable than any general recommendations which might be submitted by the committee as a whole.

Your committee further recommends that a permanent committee or committees be appointed, whose duty it will be to investigate any one particular subject which may be brought out in the discussion, and which will in your judgment be of most interest to the members. This idea is not original with your committee, but is based on the lines of the committees of the Association of Edison Illuminating Companies, who have such committees as the following: Meter Committee, Committee on High Potential Work, Committee on Rates, Committee on Theft of Current, etc., etc.

By having two or three men, who are residents of the same district, investigate the same particular subject, I think we would be able each year to present some very creditable reports for your consideration; as an illustration, you might have a committee to make a report on High Potential Insulators confining themselves exclusively to this subject. Another committee might be appointed to render a report on High Potential Transformers and if you desire to extend the scope of your association to the Distribution of Energy as well as its Transmission, you can find a number of interesting subjects on that end of the business.

At the last meeting there was a considerable tendency to discuss the effect of a Street Railway load on the system of distribution, Mr Lamme has, therefore, for his part of the work, very kindly offered to write a paper on the "Single-Phase Railway Motor," in order that the members may see what influence this new feature in railroad work may have on their distributing systems.

Another feature which entered largely into the paper on "Local Distribution," and the discussion of same, was the question of Regulation. This is probably one of the hardest problems which we can encounter and realy constitutes two distinct parts—the Regulation at the power house and the regulation of the current after it reaches the sub-station. A great deal has been done along these lines since our last meeting, and Mr. Lighthipe and Mr. Hutton will both give you some valuable information on this subject, accompanied by charts, which will speak plainer than words.

Mr. Balch in his paper on "Experiments with Extremely High Tension," will give you some valuable food for thought, and we trust open up a very liberal discussion.

There were a number of other subjects discussed in connection with the paper on "Local Distribution," which seemed to have settled down to standard practice, for instance in the matter of Regulator Heads, we are all agreed, as suggested in the paper of last year, that these should be immersed in oil, they practically being switches, and in this connection would state that as near as the committee could find out, nearly all companies are so constructing Regulator Heads and other switching appliances.

Another subject upon which we are all agreed is the question of using only secondary currents for measuring instruments, and in this connection we find that all the large makers of instruments are now providing current transformers. We believe that of the instruments in most common use, the hot wire instrument was the only one that did not operate through a transformer, and we are informed that these instruments are now supplied with current transformers in place of shunts as heretofore. This your committee thinks a step in the right direction.

In the manner of Feeder Regulator, your committee would state that the regulator referred to as "being brought out" in the paper last year, is now on the market, but we have been unable to receive any reports on the operation of the same. This regulator is not materially different in its electrical operation from those now in existence, but mechanically it has a decided advantage in that the time element practically disappears as the regulator will go from the extreme buck to extreme boost in a few seconds.

In regard to the question of the distribution of secondary currents at 200 volts, your committee takes pleasure in reporting that this is becoming more and more general. In case of one company, with whose work your committee is familiar, they have installed since our last meeting in the neighborhood of 3000, 200-volt meters, all of which are giving perfect stisfaction. A large precentage of these were installed on circuits of the three wire type with 400 volts across the outside wires.

There seemed to be last year a good deal of difference of opinion in regard to the 200-volt lamps and their future possibilities, and your committee has collected considerable information regarding their manufacture. We find that the output of 200-volt lamps is increasing 75 per cent. per annum. One company alone is producing over a million 200-volt lamps per year. They are made in efficiencies of from 4.37 to 3.4 watts per candle in sixteen and twenty candle power lamps and down to 3.1 watts in twenty-four and thirty-two candle power lamps. In candle power they can be bought from four to 100 candle power.

There is one very important point in the purchase of 200-volt lamps, and that is to avoid ordering 200-volt lamps. Better order 210. 215, 225, 230, 240 or 245 volts.

Those who are especially interested in this question should read the papers by John W. Howell and Philip Torkio, read before the Institute of Electrical Engineers.

Trusting this report and the papers which your committee present will meet with your approval and bring out a liberal discussion, your committee begs to remain

Most respectfully yours,

GEO. C. HOLBERTON.
F. V. T. LEE.
W. F. LAMME.
J. A. LIGHTHIPE.
A. C. BALCH.

THE CHAIRMAN—You have heard the reading of this report. We would like to hear from Mr. Clark regarding this, regarding anything in connection with the latter part of the report, for instance regarding illumination with 200-volt lamps such as the Nernst lamp.

MR. CLARK—The Nernst lamp has been on the market long enough so that many people have had experience with it. Some people report adversely to the lamp, but I have recently spent some time through the East and at the Pittsburg factory of the Nernst Lamp Company. I know that there are enough absolutely successful installations of the Nernst lamps to prove that they are a big success where properly cared for. The fact that the Nernst lamp requires a little bit more attention than the incandescent has in some cases discouraged its use. Some station men were not disposed to undertake the necessary care or change of system; for having both incandescent and arc lamps, they did not want to complicate it. But the Nernst lamp has a sphere of its own, especially on 200-volt work. Occupying a field, as it does, between the

arc lamp and the incandescent, it fills a void that we have had for some time. The efficiency of the lamp designed to take the place of an alternating arc is very good; it shows up very much better than the alternating arc. The striking advantage of the Nernst lamp is the better color of the light, and the fact that the light is entirely within a hemisphere from horizontal to horizontal, while with the alternating current arc the illumination is through the hemisphere, from vertical to vertical. With the Nernst lamp we get our maximum illumination directly under the lamp; with the arc lamp we get it at an angle of about 73 degrees from the vertical. It is probably not generally known, but we have in operation now on the Pacific Coast over $80,000 worth of Nernst lamps, which are scattered pretty generally. I don't see very many of them around, but they are in successful operation. There are very few complaints from those, and we are increasing the number in use every day. Mr. Wurtz and the engineers associated with him on the development of the Nernst lamp decided on the 200-volt lamp for the reason that it was more advantageous to make a 200-volt Nernst lamp, and also because they anticipated the trend toward higher potential in the distribution of current. They believed fully that it was only a question of time until incandescent service would come to 200 volts. That was one reason for adopting that voltage. It is very easy to make a Nernst lamp for a higher voltage. Four hundred volts shows a better efficiency than does 200, but they figured that that was a little bit high for ordinary distribution, and that the potential that would ultimately be arrived at and maintained would be approximately 200.

I received a request from some of the members of the Association to have some Nernst lamps on exhibition here, but I came in so late that I have not got them. I expect to have some to-day, and should be glad to take the matter up thoroughly with any one interested in the matter. I didn't know that I would be called on to say anything regarding the lamp, or else I would have had some data regarding it here.

THE CHAIRMAN—Are you making a 200-volt one-glower lamp?

MR. CLARK—Yes, 200 and 210 volts in single globes, in all lamps. That we regard as a standard lamp. The 110-volt lamp is made to meet the conditions at the present time. We have several alternating current installations with Nernst lamps. Where it is necessary to use an incandescent lamp, we are using 200-volt lamps. One installation, which is in operation very successfully, is in the State Capitol at Olympia, and there we have alternating current generators instead of direct current machines. The potential of the alternating current generator is 200 volts. The trouble with the 200-volt incandescent heretofore was the endeavor to make it too highly efficient. Now, they are figuring their lamps in general practice at from 3.4 to 3.8 watts and are giving more service.

(The convention here took a reccess until half-past one o'clock P. M.)

TUESDAY AFTERNOON, JUNE 21, 1904.

THE CHAIRMAN—We will open the afternoon session with the reading of a paper entitled "Possibilities of Single-Phase Electric Power Transmission," by Messrs. Bullard and Sprout.

(Mr. Bullard reads the paper.*)

THE CHAIRMAN—The paper we have just read, I should think, would call for considerable discussion. Some of the things enumerated in it are quite a departure from ordinary practice at the present time.

MR. CORY—I hesitate about making a suggestion, for I think we are all very anxious to discuss this paper; but would it not save a good deal of time if we could have the paper read upon "The Alternating-Current Single-Phase Railway Motor," and also the paper upon "Single-Phase Motors," and have the discussion all together? It seems to me that the possibility of single-phase transmission will depend a great deal upon the use of single-phase motors. That is a suggestion only and I don't know whether it would be best or not, but if we could discuss all three papers it would save time.

THE CHAIRMAN—If there is no objection we will next take up the paper by Mr. Lamme, entitled "The Alternating Current Single-Phase Railway Motor."

(Mr. Lamme reads the paper.*)

THE CHAIRMAN—We will listen to Mr. Elder's paper on "Single-Phase Motors."

MR. R. B. ELDER—Some one has said that knowledge is cumulative, that we advance in wisdom, sometimes on other people's shoulders. The meat of this paper is to a large extent furnished from the opinions and experiences of Mr. W. A. Layman of St. Louis, who has so persistently devoted his entire time for many years to the development of the single-phase motor and the proper place for single-phase transmission.

(Mr. Elder reads the paper.†)

THE CHAIRMAN—The three papers presented I should think would call for considerable discussion. I now await discussion by the members. Can I hear from you, Mr. Babcock?

MR. BABCOCK—I have had so little experience in single-phase work that I don't know what to say. I have never had anything to do with single-phase circuits, except in the old lighting days, and that is hardly to be considered at the present time. It strikes me that Mr. Lamme's paper is somewhat significant of what may be expected in the immediate future.

THE CHAIRMAN—Have any of the members had any experience in connection with single-phase distribution and utilization of current in the manner presented in the papers?

MR. B. C. CONDIT—One of the points that Mr. Bullard brings out is the grounding of one side of the single-phase circuit. If you take a three-phase circuit and ground one side of the circuit and have a ground return, you would take less copper than for the single-phase. Also, if you take two-phase and have a neutral common wire return and ground that wire, you would have the same amount of copper in that case as in the single-phase. That is one point.

With reference to Mr. Elder's paper, he mentions a starting power factor in his motor of 90 to 95 per cent. As I understand the Wagner single-phase motor at start, it is nothing more than a transformer type of series motor. If that is so at the start, we know that a series motor gives no energy so far as rotating goes; and if it gives a power factor of 90 to 95 per cent., that means the energy put into the motor at the start before any work is delivered is almost equal to the power applied. That would indicate that the internal loss of the motor was quite large. I would like that to be cleared up, if my understanding is correct.

MR. H. A. BULLARD—In regard to the matter of copper in multiphase using this ground return and grounding one of the phases; taking the single-phase two-wire as 100 per cent.;

*THE JOURNAL, July, 1904, page 195.

*THE JOURNAL, July, 1904, page 208.

†THE JOURNAL, August, 1904, page 230.

your multiphase with one wire grounded would require 50 per cent., which is just the same thing as the single-phase with one wire grounded, which calls for 50 per cent. of the copper. You would have then two overhead wires, necessitating your cross-arm, two pins and two expensive insulators, which is one of the greatest points we make for the single-phase—the elimination of this extreme expense in transmission line construction per mile.

MR. LIGHTHIPE—One point that Mr. Bullard brought out refers to the advantage of star and delta connections. He says:

"A 15,000-volt initial generator potential three-phase may be obtained by an 8070-volt winding connected in star, whereas the same potential single-phase would require a 15,000-volt winding."

So far as the insulation goes, it is all right; but the main advantage of the three-phase star winding in a machine is that we have that less number of turns to develop the same voltage at our terminals, and the number of different turns required between 8070 compared with 15,000 volts is quite material. It means you have that much more room in that armature for insulating purposes.

MR. BULLARD—But with the three-phase you have so many more slots per pole than with the single-phase.

MR. LIGHTHIPE—I agree with you.

MR. BRIGGS—One thing occurs to me in connection with this discussion. You must be able to take any load that is offered, regardless of its size. There is no question as to the advisability of having a single-phase motor of small size, but as for a single-phase power transmission plant, the present state of the art seems to me a long way from home. If a man had the courage of his convictions and installed such a plant and came around and tried to talk, for instance, to Dr. Bockman of the Standard Portland Cement Works with reference to running his 800-horsepower motors, he would have quite a job to get the contract. But his present polyphase motors work satisfactorily, and the power corporation could take on a greater number of these plants under the same conditions and operate them successfully, where they could not do so with single-phase motors of any kind. The single-phase motor of the railroad has its limitations in power work, because it is limited to twenty-five cycles; it is not applicable to the 60-cycle current in general use in this State. It occurred to me in discussing the question of power transmission plants, that we ought to have the whole plant worked out as a complete unit before we can take up any part of it, and if none of the manufacturers are prepared to make a single-phase motor as high as 1200 horsepower with the tendency of modern times to go into larger motor installations, single-phase power plants are not to be considered.

MR. BULLARD—Mr. Briggs loses sight of the title of the paper. I want to emphasize the word "possibility." We don't claim that the thing is of to day. We do say "if the demand is created for these large single-phase motors," I think Mr. Elder will bear me out and I think the Westinghouse people will, too, in the statement that the single-phase motor for these large installations will be made if we create a demand for it. Why are we planning to-day for three-phase in our transmission lines? You ask almost any engineer that, and his answer offhand will be, "Because we save 25 per cent. of the copper." On our showing, you save 25 per cent. more for copper and at the same time you get a much more simple construction. We show you that you can get these larger motors if the demand is created for them. As an engineer, if anybody should come to me to-day and ask me to plan for him a power transmission plant, I would no more tell him to put in a single-phase than I would attempt to fly. One is about as remote as the other. I don't know but what the single-phase is more remote than flying at the present time.

MR. LEE—There is another point, and that is that the cost of transformers would be considerably more. A 15,000-volt transformer with a delta connection, single-phase, will cost more than an 8000-volt transformer used in star for 15,000 volts. There is no question about the adaptability of the single-phase motor, but I think the single-phase motor in large sizes will probably cost more than a three-phase motor would. Moreover, where the sizes are large enough to justify a polyphase motor, the simplicity of the polyphase motor is something in its favor as against the single-phase motor. It is, of itself, self-starting. The single-phase motor as at present developed is self-starting, and starts as a repulsion motor, but it has to have something extraneous to convert it to the induction motor pure and simple. While it is very useful and fills a long-felt want in small sizes, I think we are a long way from its adaptability in large sizes.

MR. BULLARD—In answer to that, as far as the adaptability of the single-phase motor is concerned, I think that we can claim that the single-phase motor more closely resembles the characteristics of the direct current motor in its diversity of application, just as said in the paper; and the complications which may be incident to the use of the single-phase motor, to accomplish those results, I think are warranted. We are not having any trouble with these single-phase motors, or with the direct current motors, appreciably. Admitting that the multiphase motor is simple, it does not approach the characteristics of the direct current motor in its diversity of application.

As to the cost of single-phase motors being greater when you get into the larger sizes, if we admit that that is true it comes back to what we said about the extra cost of a synchronous motor, single-phase. The cost of the motor is borne by your customer, and never will assume the proportions of a serious item in any case. As to the cost of transformers, admitting that the multiphase transformer for a certain potential, connected in star, gives you the same voltage that the higher winding on the single-phase transformer would give you, we again have that question of using only one transformer as against three to offset that, and my impression is that the difference in cost between 8070-volt winding and a 15,000-volt winding is only about 5 per cent. Am I right, Mr. Lee?

MR. LEE—I think about five or six.

MR. BULLARD—And the one larger transformer as against the three smaller would probably save you about 15 per cent.

MR. BRIGGS—I will have to take issue with Mr. Bullard in reference to the single-phase motor and its peculiarities. The development of the polyphase motor has hardly reached the top notch yet, so far as I can find out. Our company is continually bringing out new applications and new developments in that line. When I first joined the Westinghouse forces six years ago there was hardly a satisfactory hoist motor on the market. To-day there is a very large number of installations, using alternating current motors for electric hoists and overhead traveling cranes. We are on the market with a two-speed motor, and will have one in three and four speeds, where the motor will operate at 25%, 50%, 75% and full load speed with good efficiency. It leaves little to be called for in regard to the flexibility of the polyphase motor. I don't know how the single-phase motor could be used other than that which we are using on railroad work, which has to be 25 cycles.

THE CHAIRMAN—We must not lose sight of the second paper that was read on "Electric Railways, Single-Phase." We have heard no discussion in connection with that paper.

MR. COPELAND—One question I would like to ask. That is in designing single-phase, is the power factor allowed for, and if so, does not that counteract the question of efficiency; that is, as regards starting? It is argued that the alternating current motor is more efficient at starting than the direct current motor, because in it a choke coil is used. That lowers the efficiency of the line and at the same time raises the efficiency of the motor, it seems to me.

MR. BABCOCK—I think that Mr. Copeland has hit the right idea so far as railway motors are concerned. I would like to hear that point discussed, because I happened to be present at the meeting of the Electrical Club in Pittsburg when Mr. Renshaw read his paper on the single-phase railway motor. He made some statements as regards the effect of power factor on the motor that seemed to me to be a little unusual, and when I questioned him on this point he expressed great surprise that I would raise such points, saying that the matter was of no very great importance. It has usually been my experience that the effect of the power factor on an inductive line is of considerable importance, and I would be very glad to have Mr. Lamme discuss that point if he will.

MR. W. F. LAMME—The power factor question is one that might be very serious on occasions, but yet when you come to look at the thing in detail, it is not very serious.

In the first place, when we start our motor we don't start with very high voltage but only a portion of the voltage which we use when we run. The current going, say, is something like full load current. If that is so, and you only apply one-fourth of the voltage, then you will only apply one-fourth of the current to the generator which affects the voltage. That is one point.

With reference to the low power factor, some people seem to think that a low-power factor at the start is a very serious matter. It is in some motors but it is not necessarily so in a series motor. With a series motor when we start we deliver no energy. The only energy in the motor is that taken up in the winding, and the voltage applied is made up of the inductive part at right angles to the energy part. If we consider that point and look back upon the generator, we have very little current on the line. We use all the current required to start the motor. To put that upon the line, you would only have one-fourth of the current required for that motor at full load. Therefore, the effect is not very serious.

MR. COPELAND—What I was taking issue about was advantage No. 2. We all admit that the single-phase motor is a common thing in railway work, but there are just a few little points in regard to advantage No. 2 of Mr. Lamme's original paper. Suppose that the motor had 100 per cent. power factor all the time, both at starting and in continuous operation; would it make any difference with the size of copper that we put into the distributing system to get to that motor? That is the gist of the question. Otherwise, if we do have more copper to prepare for this lower power factor, then that annuls the monetary efficiency of No. 2, anyhow.

MR. LAMME—The prevailing opinion is to compare the series alternating current motor to the induction motor. We all know that many induction motors, when you throw your line on, take an enormous current. This is not the case with the series motor. All of the current applied to the series motor is useful current in that it develops torque—all of it—and the power factor comes in the fact that we apply higher voltage to get this current through. We have an inductive resistance in series with the line on which the current is applied. In the power factor it goes in the voltage, not in the current, as it does in the induction motor.

MR. BABCOCK—Mr. Lamme has stated with some clearness the views held by his factory engineers. It seems to me a great mistake, in a question that has to be met and discussed and settled, that the main point in issue should be persistently dodged. I am very glad to hear him say to the effect that all the current is to be used for starting the train. I would like to ask him, in the illustration where he says one-fourth of the full load current of the motor is put on the generators, what he would expect an engineer to say if told that he could have only one-fourth of the power of his motors to accelerate that train? You would be all day getting up to full speed. I am not disposed to discuss the effect on the motor, or whether it is a repulsion motor, or a series motor, but what I am after is to find out how much copper I have to put in that line, how much transformer and generator capacity, to get the train under way to full speed and running. This is the point I have not been able to bring out either in the factory or here—a point that will not be discussed, aparently, because it is persistently put to one side.

MR. LAMME—I presume the gentleman is aiming at the point that the motor takes from the line an enormous amount of current. I admit the motor, itself, takes current, a pretty large current, but that total current is not carried back to the line. That total current is not carried back, because it is divided up in the transformer itself. Say we have a pretty large current, at 100 volts, applied to the motor. When we apply 400 volts to that motor and apply the same current to the motor, you take four times the current from the line. That is the point I was trying to bring out. When we are starting, we are applying low voltage, not a high voltage, and the current is cut down by the winding ratios in the transformer, and not by the resistance. That is the difference.

MR. BAUM—I understand that Mr. Babcock wants to start a train at a certain rate of speed, that is, at a certain acceleration, and to make up the speed in a certain length of time, say five or ten seconds. The energy required to bring that train up to speed during the time of acceleration is greater than the energy required to keep the train in motion at full speed. He wants to know where that energy comes from that is to start that train, the energy being greater than the energy necessary to keep the train at its final speed.

MR. LAMME—Say we apply a certain amount of energy at the start of the train; we start that train with that current. We keep that current on until we get that train up to above speed, or to its average speed. When we are above that average speed we are taking more energy from the line than we were taking at the start. That, I think, is clear. It naturally would follow, assuming the same current from the time you start until you get to maximum speed. You use more energy at the point when you get to maximum speed than when you started.

MR. BRIGGS—I think one case might be cited that applies to Mr. Copeland's inquiry. I will refer to the report of Mr. Sargent, of Sargent & Lundy, on the Cincinnati and Springfield Railway. The engineering of this road was taken up by the Chicago engineering firm. The road was planned as a polyphase installation, using rotary converters and generators. Before the road was installed it was finally determined to install the Westinghouse alternating current single-phase system, and in Mr. Sargent's report to the board of directors they have determined that it will save $500,000 to equip the road with alternating current equipment instead of direct. Being somewhat of a Missourian it would be difficult to convince me that this was not a good thing.

MR. BABCOCK—I don't seem to be able to understand the point. Mr. Lamme admits it takes more to start the train than to maintain the speed. It strikes me that power has to come from the power house over the line, and according to his admission, the power factor is exceedingly low. What effect will that have on the regulation of the system as a whole? When I start one train, am I going to stop all the rest of them?

MR. LAMME—I did not intend to say that the train takes more energy at the start than when it is at full speed. The train does not take as much energy at the start as it does when it is getting up to the maximum point. It takes less energy, and from that point on it builds up in its demand from the generator. It takes less from the start, and builds up at the maximum point, and then begins to drop off. That is only agreeable to the theory of the series motor. The aim of all these systems is to apply a certain amount to the motor at the start, and keep the current constant until we get up to full speed, which will generally be the full voltage applied, with all the resistance cut out. With the alternating current motor we do that by applying varying voltage; we start with a low voltage and keep the current constant until we get to a point where all the voltage is applied that we can, and from that point on it dies down.

THE CHAIRMAN—By means of this transformer with the several taps?

MR. LAMME—Yes; by tipping the coils, which is the same thing as taps.

MR. LIGHTHIPE—Constant amperes and constant torque give uniform acceleration.

MR. BABCOCK—Any power curve that is taken on acceleration shows what is going on. There is always a peak before constant speed is reached. I don't see how Mr. Lamme can claim that it takes no more power to accelerate a train than to keep it running at constant speed. Every power curve will tell him that that can not be so. If curves mean anything, they tell you that.

MR. HUTTON—In the matter of acceleration, the power that you take will depend on the speed of the acceleration. If you accelerate the speed of a train very fast, you have to give it quite a large amount of current, the same as you would with a direct current system. With direct and alternating current motors on a car, the only difference between the method of starting is that with the direct current, if you have two motors to start, you have to start the two motors in series with resistance which is gradually cut out. Then the motors are thrown in parallel and resistance is inserted, and finally the start is made. With the alternating current motor, instead of cutting down the voltage across the motor with the use of resistance, it is done with the auto-converters, and I understand the same acceleration can be gotten with an alternating current equipment with slightly less draft on the line than it can with direct.

MR. BABCOCK—Mr. Hutton has mixed up the two things. It is true that you can get the same acceleration from the alternating current motor by the induction control, with less work done, because you don't use resistance. But Mr. Hutton and Mr. Lighthipe will remember that, admitting that the current is constant the voltage is always greater and greater and consequently must be taking more power. I don't see what the power curves tell us, if they don't tell us that very thing.

MR. LAMME—I think Mr. Babcock is correct in his statement, and it agrees with mine, that when you start you don't take as much energy as you do when you get to high speed.

MR. BABCOCK—I don't mean to get in that position. I must be unfortunate in my use of words——

MR. LAMME—That is the opinion I have expressed.

PROF. CORY—I have a few words to say about the first paper, as to the possibility of single-phase currents. I think if we look at this paper as Mr. Bullard has outlined the possibilities of single-phase currents, we will very definitely lay down the general principles that have been clearly set out in the third paper, Mr. Elder's, that for large motor loads, polyphase currents are to be preferred. We can see what possible application there may be. I do want to take issue with the authors of that paper, Mr. Bullard and Mr. Sprout, upon the statement under their section 5, which states: "While it is admitted that the cost of copper for a single-phase station will be 33⅓ per cent. more than for three-phase, on a strictly theoretical basis, yet it is a fact that in actual practice it will seldom be found more than 15 per cent. greater, and this is more than offset by the saving in labor required to wire the station for single-phase, which saving will be 33⅓ per cent. in every case."

I doubt, absolutely, that 15 per cent. If there is anything true in the world it is true that a three-phase current requires only 75 per cent. as much copper as single-phase. It is 33⅓ per cent., and not 15 per cent. No conditions can arise which will make that anything else than 33⅓ per cent. I mean 33⅓ per cent. less for the polyphase than single-phase, or the other way, 25 per cent., less, or 75 per cent. for the three-phase as against the single-phase. If section 5 refers solely to the switchboard, very good; but when we come to the transmission line, take simply the case of two circuits, No. 4 copper, forty miles in length, weighing 660 pounds to the mile, would mean about $210 per mile saved by using the three-phase system. That is 8400 for a forty-mile line. Eight thousand four hundred dollars will pay for a whole lot of appliances that you might add to your switchboard, the difference between three wires and two wires. Do I understand that that refers solely to the switchboard in the substation?

MR. BULLARD—It refers to station wiring, exclusive of switchboards, from generators to switchboard, and from switchboard to the point where the wires leave the building.

PROF. CORY—What I have said would then apply to the line construction taken up under their section 14. Under section 9, regarding rotary converters, there is no doubt that the efficiency of the polyphase rotary converter is greater than the single-phase. The ideal rotary would be a six-phase rotary converter. So far as rotary converters are concerned, if they are to be used at all, the polyphase rotary converter is a better converter than the single-phase rotary converter.

One point, it seems to me, of very great importance in this paper is the fact that we could not ground one side of our single-phase line, nor could we ground one of the three wires of the three-phase line, if we ever intended to use a telephone in that state. It can not be done. As far as copper is concerned, you will save just as much by grounding one of the three wires. Both require the use of the earth as a return conductor.

To take up the matter of alternating single-phase railway motors. As I understand the present situation as presented by the two large electric companies, the present single-phase railway motor is a motor which is a good alternating current low-frequency motor, and it is also an excellent direct current motor, and can be used on either system. Assuming that we have the proper voltage in each case, a motor of this character could be used on a direct current system, and immediately go on another line where there was an alternating current supply of low frequency. The railway motors will be used in series on starting. As Mr. Elder has brought out, the power factor of a series alternating current

motor is not low, comparatively. What we want is torque in order to start that motor, and this torque depends on two things—the current in the armature and the current in the field. The only difference between the direct current and the alternating current motor may be that the current in the armature and the current in the field is not in phase, in which case you would get a less effective torque. But so far as starting the train is concerned, and calling for power from the power house, the alternating current motor should not be inferior to the direct current motor. The comparison of the single-phase alternating current motor with the direct current shunt motor in Mr. Elder's paper has seemed to me to have a rather direct bearing. I think we will all admit that up to a certain horsepower—and from Mr. Elder's paper that seems to be about 30 horsepower—the single-phase alternating current motor is as good as the direct current shunt motor. But those of us who have seen induction motors used in the mines, on dredgers and in cement works, know that the induction motor is infinitely better than the single-phase. It is at least better in many cases. If 2000 volts is applied to the stationary part of the induction motor, on the part that is rotating it is probable that the voltage is not over 150 at most. It is a hardy machine; there is no commutator. As Mr. Elder has brought out, it is not that the single-phase motor is in competition with the polyphase motor, but the polyphase induction motor, particularly for large loads, is a magnificent machine. There is not a prime mover that compares with it, and the direct current shunt motor is not in the same class so far as simplicity is concerned. We know perfectly well that we don't have large induction single-phase motors; we have small ones furnished by the electric companies, but not large ones.

MR. CLARK—There is one point in Professor Cory's remarks that might be misinterpreted. Of course, the single-phase alternating current railway motor is a good direct current motor, but it will not operate on the same potential. A direct current operates on a very much less potential.

PROF. CORY—I understand that. I should have said the proper potential.

MR. CLARK—I recently went through the matter very thoroughly with Mr. B. G. Lamme at Pittsburg and he is putting in an alternating current railway motor with myself in the State of Washington. I had the same thing laid out for a single-phase railway equipment up there.

Referring to the matter of economy in this particular instance, after it was all worked out and everything said and done, we saved 1¾ per cent. over the cost of putting in an alternating current equipment. There were 33 miles of line, all told. But in this case it is not a question of generating 24 cycles. I have put in 60 cycles and put in frequency changers which more than balance the cost of the rotary converters. I had to put in two of them to handle the load correctly. I had to convert it from 60 cycles to 25 cycles to save the cost of pole line construction and transmission copper. That is the principal saving. There is a little saving in the central station. We save something on frequency changers and rotary converters. At one end of the line I figured on running over the tracks of the present street railway system. I figured on the advisability of putting in the necessary equipment, throwing over to the alternating current and going on to that trolley wire. I found it inadvisable to do so from the fact that I had to cut out the alternating current and put in a lot of dead resistance. I had to throw my motors in series, recent remarks made by Mr. Lamme in Pittsburg, and he leys. I frequently worked that out to my own satisfaction, and thought it would pay me to put in two trolleys, and I does not recommend that, but instead recommends two trol- and that brought in a lot of complications. In fact, it was pretty hard to use the same controller. I have seen some laid out my scheme up there to run the alternating current trolley alongside of the regular 500-volt direct current trolley in the city. I got 250-volt motors, so I have had 250-volt alternating current trolleys and 500-volt direct current trolleys. In place of throwing over the trolley on the direct current, throw out the circuit breaker. If the direct current trolley was put on that alternating current system, the motor would not stand up, and I would protect my alternating current apparatus by the use of circuit breakers. I found it advisable to put up an additional trolley wire, instead of running on the direct current system in the cities.

PROF. CORY—How many cars did you intend to operate on that line? What was your maximum power?

MR. CLARK—I figured on a capacity of 2000 kilowatts.

PROF. CORY—Still, your saving was only about 2½ per cent.?

MR. CLARK—Three or four per cent. That was in great measure taken up by frequency changers.

MR. BABCOCK—I recently figured out a scheme much the same. I found that in an installation that involves in the neighborhood of 8000 to 10,000 kilowatts, the first cost of the alternating current and the direct current compared so near alike that you might say it was within the limit of error in the figures. I considered it was of no account, because it was less than one per cent., and one might easily make that much of an error in an estimate of size. As to operating costs, all things considered, the operating cost was even less in the case of the direct current than in the case of the alternating current. The conditions are a little peculiar, it is only fair to say. But for the reason that they were so close together, it seems to me that a reasonable caution would compel a man to take the direct current apparatus, which is less complicated, perhaps, than the alternating current, in a plant of that size, and therefore, it seemed to me, that the alternating current apparatus should not be considered in that installation.

PROF. CORY—Did you have frequency changers also?

MR. BABCOCK—No, I had no frequency changers, because I was figuring on an original 25-cycle steam plant, so there was nothing of that kind to complicate it. It was a straight comparison between the steam generating plant and the distribution in both cases.

MR. CLARK—One point I have not heard brought up. It is necessary to operate at times a heavy electric motor in handling freight. I figured on using a high potential trolley. It would be quite out of the question to handle a direct current trolley, or to use direct current motors, and carry the amount of current required and not burn up the wire, in the ordinary standard trolley wire.

PROF. CORY—What potential did you use?

MR. CLARK—Six thousand volts.

MR. HUTTON—If you use 6000-volt trolleys on suburban railways, won't our telephone man get in his work again?

MR. BABCOCK—I would like to hear that point discussed.

MR. HUTTON—Going back to Mr. Elder's paper, there is no doubt but what there is a great field for single-phase motors, but that all lies in the smaller sizes. We had a case where we wanted to run about five thousand feet, and were going to take on about 40 horsepower in motors, and these motors were going to be pretty well bunched, and it would take about a 30-kilowatt transformer capacity. That line being about 5000 feet long, we figured on a No. 6 wire to cost $180, and the cost of a 30-kilowatt transformer was $280, making a total of $460. Making it three-phase, the copper cost $135 as against $180, and the total cost for the three-

phase motor was $453 as against $464. The only other expense we will be put to on the three-phase will be the running of one extra wire, or the insulators and the pins, which amount to $3.24. So on eight motors of about five horsepower I would still have a saving of about five dollars, and still use polyphase motors. I have always considered that polyphase motors put the others in the shade, when it comes to keeping out of trouble.

MR. BABCOCK—I would like to ask Mr. Clark if he considered what would be the effect on telephone and telegraph service of a single-phase grounded railway motor. Was that considered?

MR. CLARK—It was considered very thoroughly. They did not have much data, but they figured that we would bond the road. We did not have a large current to carry back. We could bond the road effectively, and make a low resistance circuit through the rails, and the low resistance would bring back comparatively a small quantity of current. We were going to experiment on that. I thought we would have some trouble, but this might not be severe enough to cut out the telephone system entirely. We don't have to consider the commercial telephone system, because it is several miles away; we would only have to consider our own telephone system, parallel with this line. If it became necessary, we could put in a telegraph system. We figured that with the low amount of current to come back we could bond the rails so as not to interfere with the telephone.

MR. COPELAND—If a telephone were located on the crossarm instead of on brackets and its line wires were properly transposed, there would not be very much interference with the telephone. The induction in that way comes on two wires. That is a theoretical consideration. In practice, I don't know how it would work. I know for a certainty it would not work with a three-phase circuit with one wire grounded, because we have tried that, and it did not work. And then the Western Union Telegraph Company always calls us up every time we try to do that.

PROF. CORY—I had in mind the people who were trying to operate the telephone companies, more than the ease of a transmission line using its own telephone. In Sacramento we had an experience with those conditions.

MR. BULLARD—I just want to take up the three matters that Prof. Cory spoke of. In section 5, the matter of 33⅓ and 15 per cent. refers particularly to the wiring in the stations, and not in any way to the transmission line. The way we arrive at that figure is this: In the majority of stations, instead of drawing in actually the wire that is required, we find that they are drawing in a considerably larger wire than is required, in almost every case, and that more particularly because they can't get precisely the size of wire or cable they need. While the theoretical difference is 33⅓ per cent., in actual practice it seldom exceeds 15 per cent. That has little to do with the argument in favor of the single-phase, for the reason that if we admit that there is 33⅓ per cent. difference, we would still have a saving in favor of single-phase, on account of the labor item, the drawing of those wires into place.

As to the matter of rotary converter efficiencies, in the first place I would state that it is our idea that the rotary converter will be eliminated almost entirely, if the single-phase be adopted for railways. Be that as it may, while the efficiency of rotary converters reaches its maximum in a six-phase machine, is it not true that the difference in efficiency is very slight, anyhow? In other words, the efficiency of a six-phase rotary converter will be somewhere in the neighborhood of 96, and with a single-phase you would get an efficiency of 94½.

PROF. CORY—About 95 per cent. It is only that last paragraph that "a single-phase rotary will be found quite as cheap and satisfactory as a multiphase rotary." I doubt that in general operation.

MR. BULLARD—As far as the efficiency is concerned, your customer pays for the difference in efficiency. Hence, I always look at it from the standpoint of the man that is generating the power. The fact that your customer has to pay a little bit more for the appartus that he is using, and for the current he is consuming, does not concern you; in fact, you like it. I know people who are putting a motor on the market for a ridiculously low price, who say "If this motor does not give you satisfaction, if this motor gives you any trouble inside of the next year, we will replace it absolutely free of cost." Why? The central station can well afford to, because it is such an inefficient motor they are making money out of it. You know the same thing used to be done with the incandescent lamp.

The question of the telephone has been already brought up. I would like to ask that we be informed just what effect the grounded single-phase circuit would have on telephone lines. It seems to me if the telephone line is balanced with respect to the one wire of the transmission circuit, and properly transposed, we could reduce those troubles from induction to a minimum.

MR. LIGHTHIPE—Did you ever try to talk over a telephone grounded on one side?

MR. BULLARD—I have, and cussed as much as anybody.

MR. BAUM—Mr. Bullard started out here on the assumption that he is going to carry his current through the ground return. Have you ever made any experiments as to how much current you could carry over a ground return of about 150 miles? We have had a little experience in that connection. Perhaps he knows a little bit more than we do. We are all wrong. We are working three-phase; what he wants is single phase; if Mr. Tesla were here we would have this thing to its limit as he wants to get rid of wires altogether.

MR. VAN NORDEN—About a week or ten days ago, on our line of about 27,000 volts, star connection, there was a disturbance on one of the wires. This line is perfectly balanced and transposed and has a telephone line underneath it which is also perfectly balanced and transposed and perfectly quiet. Something happened to one of the wires, so that we were feeding but two wires with the neutral connection grounded. At the time it happened I started to use the telephone and a man in the station said to me, "You better look out, there is 27,000 on the 'phone." I said, "That is impossible." The fuses were out of the telephone. I replaced the fuses and in doing so drew an arc about two feet long, which nearly put me out of business. It was absolutely impossible to use the 'phone at all, or get near it. As soon as the line was balanced and the third wire put in, it was again quiet.

PROF. CORY—How did the Sunset Company in Sacramento enjoy that?

MR. VAN NORDEN—They tell so many different stories.

MR. BRIGGS—Mr. Bullard seems to lay great stress on the point of the customer assuming the losses due to the inefficiency of his proposed system. My experience has been that the customer in these days is getting so wise that it is not a good idea to monkey with him, any more than with the business end of a wasp. He has a habit of calling in consulting engineers, and if Mr. Bullard's line was running alongside of my polyphase one, he would have a hard time securing power contracts as between the power consumer's engineer and the commercial agent of the polyphase transmis-

sion company, efficiencies would be pretty well gone over and that weakness of his would be fully ventilated.

MR. R. B. DAGGETT—Mr. Babcock said it took 50 per cent. of the running energy to start the train to a rapid acceleration. I understood Mr. Lamme to say that as the characteristics of the motor control were such that he could not exert any energy larger than the running energy of his train, the acceleration would be limited. Do I understand him correctly?

MR. LAMME—An alternating current motor has the same power at start as a direct current motor of equal size.

MR. BABCOCK—I must confess I am a little bit woolly in the matter.

THE CHAIRMAN—Perhaps Mr. Lamme can make it clear to you.

MR. BABCOCK—I started this thing in Pittsburg but I didn't get it cleared up there and I had hoped to get it cleared up here. But I find the same arguments used here as there, the same points of view are expressed, and I am in precisely the same position I was when I left Pittsburg. I am no nearer to an understanding of the position now than I was then.

MR. BULLARD—I want to get at this as well as Mr. Babcock. Is it not true that in order to get acceleration you do not necessarily need to increase your power? What you do have to increase is your torque. Torque and power are not necessarily one and the same thing. In other words, you can get a considerably increased torque if you have a low voltage and a larger quantity of current, which, if I understood Mr. Lamme, is what you get.

MR. LIGHTHIPE—The whole thing is a question of torque.

MR. BULLARD—I am confessing my ignorance at once.

PROF. CORY—If I understand, what Mr. Babcock is after, and what every transportation company is after when it has a great number of stops, is to start and stop the train quickly.

MR. BABCOCK—That is it.

PROF. CORY—And in so doing it necessarily requires a large amount of power at starting. In other words, if our normal rate of running, we will say, is 60 feet a minute, if you attain that speed of 60 feet a minute in ten seconds, you will require a certain amount of power. If you attain that speed of 60 feet a minute in five seconds, you will require more power; and the point that Mr. Babcock is after is, how much power you are going to require to start these trains at some fixed rate of acceleration, and not make an over-demand upon your power and your copper still be sufficient.

MR. BABCOCK—And what the effect of the power factor will be on the whole system.

PROF. CORY—The situation is one of the amount of time you are willing to give yourself to get your train under way. If you are not making many stops it is of no consequence, but if you are making many stops the question of starting and stopping is most important.

MR. BABCOCK—I would like to say in regard to that, that every time I have gone into a discussion with a factory engineer as to what size motor should be used for a given equipment for a given run and a given starting condition, he always asks me the question, "How many stops are you going to make per mile or in the whole run?" If it takes no more power to start a train than it does to keep it running, I don't see what stops have to do with it. It seems to me it would be in favor of the motor to have as many stops as possible, because then it would be cooling off; it would not be taking current. Of course this is absurd, except in the limit—a stop without starting.

MR. LAMME—This question of acceleration is one of energy. If you start a train at one mile per hour per second, you have a certain amount of energy consumed in accelerating. If you accelerate it two miles per hour per second, which is very rapid, it will take more energy. In the second case you would have to use a larger motor than in the first place, because more current would pass through the motor to get this additional acceleration.

THE CHAIRMAN—You would be taking more power while you were accelerating the train than you would after it settled down to its running speed.

MR. LAMME—Yes. You can accelerate a train rapidly and run slowly. In that case the great majority of the power is required in acceleration. Or, you can accelerate slowly and run rapidly, and in that case the larger part of the power would be consumed in the running. Those two conditions must be known in order to figure out the size of the motor. That is a simple question of engineering.

MR. CLARK—I found in my investigation that the amount of power required in the power house for starting the alternating current motors was somewhat less than the power required for starting direct current motors; that the efficiency of the alternating current motor under full speed running conditions was somewhat lower than the efficiency of the direct current motor under full speed running conditions. It averaged up so that the all-day efficiency of motors of equal size was about the same, the starting current required for the alternating current motors and the number of watts required from the power house being somewhat less than the direct current, but the full running watts being somewhat greater.

PROF. GEORGE H. ROWE—I would like to ask a question. What the power factor is of the Westinghouse single-phase motor? I understand the design of this motor is such that the normal speed of the motor is considerably in excess of the synchronous speed and that, therefore, the power factor is better than that of the ordinary induction motor. I would like to ask about what the power factor of this Westinghouse motor would be.

MR. LAMME—The standard motors which we build now are in 50, 75, 100 and 150 horsepower sizes. These range in power factor, at fully delivered power, from about 90 to 94 per cent.; rarely do they go under 90, and rarely above 94.

MR. HOLBERTON—Mr. Lamme says, on page 35, speaking about collecting currents on the line: "When we come to trains of even medium size, it becomes impossible." What do they call a medium size? I live in a specially favored country, in Oakland, where we have electric trains of eight standard cars full of passengers, and they don't have any trouble. They have not to exceed two trolleys on one train. They are collecting, roughly, about four thousand amperes on the same trolley wire with not to exceed two trolleys. That eliminates a portion of your objection. Mr. Clark says the difference in equipment is somewhere around 2 per cent. It seems to me that for a difference of 2 per cent. in the cost we are taking a pretty big chance. Does that 2 per cent. include, in your figures on direct current work, any storage battery, or anything of that kind, as against your alternating current work? In your figuring did you include a storage battery at all?

MR. CLARK—No.

MR. HOLBERTON—You have to put in frequency changers if you are going to get your current from somebody else.

MR. CLARK—Sixty-cycle two-phase converted to single phase.

MR. ROWE—There was some question in my mind whether there were not a good many other points in which the direct

current would be of advantage. One would be the use of a storage battery. You could carry over a short interruption in the source of supply, which you could not do in the other condition.

MR. CLARK—We did not figure on a storage battery.

MR. ROWE—Another thing is in reference to the speed, so far as the wear and tear is concerned; the revolutions per minute.

MR. LAMME—Thirty to forty per cent, that is all. You refer to the "Key Route?"

MR. ROWE—Yes. It is an under-running trolley.

MR. LAMME—I refer to the ordinary under-running trolley. A heavy under-running construction could be built; I admit that, and the work could be done pretty well.

THE CHAIRMAN—The General Electric Company has gotten out a single-phase motor. I would like to hear from Mr. Lighthipe in connection with it.

MR. LIGHTHIPE—I have no data at all concerning it. We are in the field, of course, and ready to equip.

MR. LAMME—I wish to refer to the case of Mr. Clark. Mr. Clark's comparison goes closely to the matter of direct current construction using rotary converters. The frequency changers, of course, take the place of rotary converters, and the figures would come out pretty close. I think if you would take a distinct power plant and figure from that, you could make some advantage in the first place with the alternating current.

THE CHAIRMAN—We will take up the paper now by Mr. H. G. Aylsworth entitled "On Securing Absolute Safety in the Use of Telephones in Transmission Service."

(Mr. Aylesworth reads the paper.*)

MR. LIGHTHIPE—I would like to ask how high a puncture test was put on that set?

MR. AYLSWORTH—I don't know as it has been tested, Mr. Lighthipe.

THE CHAIRMAN—Do you know anything further about this, Mr. Van Norden?

MR. VAN NORDEN—Possibly, in answer to Mr. Lighthipe's question, the idea of making that induction coil the way it was made was a good deal on the transformer principle, so that in case the high potential current got into the secondary winding of the induction coil, it would not puncture through. So that the transformer idea was carried out in that way.

Again, we have had a great deal of trouble in the puncturing of the winding itself. Instead of the static charge following the coil it will short from one layer to another and burn a hole right down through, and this construction was suggested partly with the idea of getting rid of that. The receiving circuit isolates the receiver, so that there is no danger of burning out the receiver board. We have only had the instrument on a few days but so far I think they are going to be very satisfactory. The fuses we now use were made by ourselves and they have been highly satisfactory. In cases where the line voltage gets across the telephone, we took a length of three-eighths hard tubing and put one end of the fuse in it, closing the tube entirely, and it will always blow before any damage is done. The generators of the telephone are very powerful so that even if there was a heavy induction on the line it would still run through, and the induction coil talks powerfully through the line. I have found in the power houses that with an ordinary telephone bell, experienced men who are used to answering bells will oftentimes stand right in front of the bell and hear it without paying the slightest attention to it, and I have often called the attention of the men to that. In fact, I have heard a bell ring right in a man's ear, and would say, "Why don't you answer the bell?" and he would say, "I didn't hear it," and then he would say, "Yes, I heard it, but I didn't think it was our call." So I have provided all the 'phones with a bell that you can hear for about a half a mile.

MR. AYLSWORTH—The winding of the primary coil has a resistance of about 1.4 ohms, and the secondary about 14 ohms, and the tertiary winding is practically the same as the secondary.

MR. VAN NORDEN—In a three-phase line if there is the slightest grounding we will have induction on the telephone line; for even in a dry day if a wire gets on a cross-arm or in a tree, you will have more or less induction.

MR. AYLSWORTH—In regard to the winding of the induction coil, no two manufacturers wind their coils with precisely the same number of turns or with the same resistance. For instance, the Sunset Telephone Company, on their solid back transmitter, use a coil with a very low primary and secondary winding, and others wind the induction coil as high as 500 ohms. That is all done in order to get the best results out of their respective transmitters.

THE CHAIRMAN—We will now hear a paper by Mr. H. A. Russell, "Some Experiences of a Salesman."

(Mr. Russell reads the paper.*)

THE CHAIRMAN—I don't think we will allow the salesmen present to enter into any discussion. Some members have requested that the discussion of the paper by Mr. DeWald on "High Pressure Water Wheels, with Particular Reference to Girard & Francis Turbines," be reopened.

MR. LIGHTHIPE—If I may interrupt for a moment, I would suggest that the secretary of this convention telegraph greetings as follows to the American Institute of Electrical Engineers now meeting in Chicago. They are in session to-day, discussing papers similar to ours:

MONTEREY, CAL., June 21, 1904.

To American Institute of Electrical Engineers, Chicago:

In convention assembled we meet in synchronism with you and transmit high tension greeting.

PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION.

Carried.

MR. VAN NORDEN—After Mr. DeWald's paper was discussed this morning there were one or two members who spoke to me in connection with the construction and the theory of the operation, of wheels of the Girard & Francis type. There seemed to be some misunderstanding as to just how this action takes place. I do not wish to go into the details of any particular manufacturer of wheels, or to make any comparisons. I will simply go into the general principle of the wheel. In doing so, it will be necessary to make some comparison, simply to show the theoretical points.

The Girard wheel is purely an impulse wheel. It is not in any sense a turbine, and the action is exactly the same as on the Pelton, or wheels of that type; that is, there is velocity and reaction. The Girard wheel takes water in at the center and discharges it through the runner, the discharge being perfectly radial. Supposing A. Figs. 1, 2 and 3, to be a chamber, or the inside of the chute case, containing water under pressure, B, B are the cluster openings, C is the gate. The runner D revolves around the chute case and has a clearance of about one-quarter of an inch. The runner is bolted to and held in place by a spider E, which is keyed to the shaft. The action is exactly the same as on the impulse type of wheel. The nozzle or the chute opening is designed as shown in Figs. 1, 2 and 3, marked B. The secret of the efficiency of

*THE JOURNAL, July, 1904, page 198.

*THE JOURNAL, July, 1904, page 199.

the wheel is in making this chute opening less than a certain thickness, which is about three-quarters of an inch, and in order to get the right proportion of opening on the wheel, we have in our case an opening about 4½ inches by, perhaps, ¾ of an inch. This makes a flat stream, so that the relative positions of the runner to either side, or to the fiber of the stream is practically the same. The bucket is made as shown at D. So that you see here the direction of velocity is possibly an angle of 20 degrees with the tangent of the wheel at that point. You strike the cutting edge at the top of bucket, and the stream is completely reversed until the direction is the same angle to the tangent as at entrance. The line of actual flow, which is spoken of in the paper, will be a line like that is, in marked relation, as if the wheel were standing still. As a matter of fact, the design of these curves must be made, so that the line of actual flow will be a curve, leaving the wheel radially. As long as the water leaves the wheel radially a complete action and reaction is obtained. Of course, the less the angle of entrance to the tangent, the higher the efficiency of the flow will be, and mechanical construction controls this to a certain extent. In a tangential wheel, one can have conditions in which the stream may be so large, or the bucket so large, and the diameter of the wheel so small, that even with one stream you would have a great deal of interference; not only with the buckets, but discharge interference with the wheel. This naturally reduces the efficiency of the wheel. In a wheel of the Girard type the velocity is fixed in comparison with the velocity of the stream. It does not make any difference how small the circle of the wheel is, because the entrance is the same, whether the wheel be large or small. We do not have the condition that is met in a tangential type wheel in which a very small wheel and a very large bucket—something on the style appearing in Fig. 4—when the bucket, on entering the stream, is in position as at A. Here is seen a great many different conditions, from the entrance until the time the bucket leaves the stream, which, of course, the design of the bucket has much to do with. At the same time, taking every position, there is a different condition shown at Fig. 4.

In Fig. 5, with every position there is practically the same condition. The speed may be as high as we wish, and yet have the same efficiency that would be possible if the wheel were very large.

MR. BABCOCK—How many nozzles in that wheel?

MR. VAN NORDEN—In a tangential type wheel, or in any wheel in which the buckets are free and the water is from more than one nozzle, there is caused more or less interference. Anybody who has had experience with wheels knows this. In other words, you can not build up a two-nozzle wheel to be as efficient as a single-nozzle wheel. This is because of the interference between the discharged water and the fresh stream; there is no control of the water after it leaves the buckets. In the condition of discharge in Fig. 5 the water is absolutely controlled, that is, each section of water coming out of each nozzle is isolated from the one before it, so that there is no possible chance for any interference. For this reason, it is possible to have as many nozzles as we please. In the multiple-nozzle tangential wheel case, theoretically, two nozzles would deliver twice as much power; ten nozzles ten times as much power, etc.; practically, that is out of the question. Where it is possible to use a needle nozzle or regulator of that kind the difficulty is obviated to some extent.

MR. BABCOCK— What is the general practice? About how much circumference would be occupied by the nozzles?

MR. VAN NORDEN—The entire circumference could be occupied if proper space in chute case was obtained.

MR. BABCOCK—What is the practice?

MR. VAN NORDEN—About forty to fifty per cent., where the nozzles are divided on two sides.

MR. LIGHTHIPE—Is that wheel horizontal or vertical?

MR. VAN NORDEN—I don't know of any wheels in this country that have been installed with vertical shaft.

MR. LIGHTHIPE—Are the chute openings adjacent? Is the axis horizontal?

MR. VAN NORDEN—Yes, in our wheels, they stand together and they are regulated from inside of the case.

MR. DOBLE—That is, regulated by a shutter with openings?

MR. VAN NORDEN—They are regulated by a revolving sliding gate. S. Fig. 2, is a smooth surface. Any form of gate which would simply slide and cut them off, one after the other, could be used.

MR. DOBLE—You open them one after the other, beginning with the one furthest to the left?

MR. VAN NORDEN—That is the idea, but between the two points p and p′, Fig. 2, the full efficiency is not obtained on the single opening until it is practically wide open. In order to overcome that, we have divided the number of chute openings and put them on two sides, and the double gate is so arranged that when one is fully opened, the other on the other side is half way opened. Instead of getting an efficiency curve as shown by the dotted lines in Fig. 6, we now get an efficiency curve that is practically even, as shown by the full line therein. In our wheels we have almost completely approached a perfect curve by cutting the end of the single gate and giving it a parabolic point.

MR. DOBLE—You can use the gate with maximum efficiency out of one opening, until that opening is entirely unobstructed, because the retardation of flow through the inlet would be such that the velocity would be low, and you would not have the slit at its point of exit fully filled.

MR. VAN NORDEN—That is very true. Of course, in opening the first chute the power desired practically overcomes the friction in the machine. If this opening worked efficiently from the time it first opened it would not take half the power derived to overcome friction, etc. When it is three-fourths opened, nearly the full efficiency on the opening is given. As a matter of fact, the difference in efficiency between three-fourths and full opening of the chute is really very small.

MR. DOBLE—That opening is probably 12 per cent. of your full opening.

MR. VAN NORDEN—If there were eight openings, seven would be running at a full efficiency, and the eighth would be running at lower efficiency.

MR. BABCOCK—Is there any objection to mounting that wheel on a vertical shaft?

MR. VAN NORDEN—I don't think so. I don't know that it has ever been done, but I don't know any reason why it should not.

MR. LIGHTHIPE—As long as you have room for the water to drop?

MR. VAN NORDEN—There is no interference with the discharge water. The effect of the water is to be thrown directly away from the wheel, there is no chance for the water to fly back and to have another bucket come and strike it, as it would in the case of a tangential wheel.

MR. HUTTON—Do you know what the segregated efficiencies of the different parts are? Do you know what the windage is, the nozzle efficiency, and also the friction of the wheel? That is taking a wheel, for instance, like yours, that runs in the neighborhood of 83 or 84 per cent., have you any idea

what those percentages are? The segregated figures? Your nozzle efficiency so much, of itself, the windage so much, in per cent., and the friction of the wheel so much? Have you any idea about how much?

MR. VAN NORDEN—No.

MR. HUTTON—Mr. George J. Henry Jr., at the last meeting, told us that he had some wheels, the actual bucket efficiency of which ran above 90 per cent., which would mean to say that you could not improve very much; in other words a good many of the losses were in windage, friction, and the nozzle itself. If you get a bucket that is simple and good away up above 90 per cent. efficiency, how are you going to improve things very much by complicating it with something else? In other words, you have a complicated gate. With a purely tangential wheel and a needle nozzle, you have practical simplicity itself.

MR. VAN NORDEN—The question of the complicated gate is purely a local question. You can make this gate just as simple, in fact more simple, than you could any other form of regulator, if you wish to make conditions for that. If you wish to impose conditions that would make a complicated gate you might bar out the wheel. There are conditions, on a low head, with low power, where the wheel would be barred out. In the first wheels that we put in we had an extremely complicated mechanism, but the reason was, that we attempted to bring the shaft through the wheel.

In order to make the chute case large enough to carry the proper amount of water and still bring the shaft through the wheel, we had to bring the box up around the wheel. The shaft is carried through, and there is a steel collar around the shaft, and around the steel collar revolves the gate. This gate is necessarily an unbalanced gate, hanging downward. There is an immense pressure here, probably forty tons, on this collar. If this were a balanced gate, there would be no pressure. This is necessarily a very short bearing, only about six inches on this collar. If this is loose in the slightest degree, naturally the flow of the water makes it come against the side of the case, which causes friction. We got around that by dividing the gate and one-half the number of chutes on either side, which balanced the gate and did away with all the complication. The whole box can be dismantled and put together in a short time. It is extremely simple. In a great many cases we are now doing away with shafts through water wheels entirely, and putting the wheels on the ends of the generator shaft. Take the construction shown in Fig. 7 for very high head wheels, where there is required but one nozzle, and there would be no gate inside at all. The nozzle opening is controlled by a single shutter. This is of solid pieces and simply fastened directly to the gate shaft.

MR. DOBLE—How would that work in water that carried considerable sand and small gravel?

MR. VAN NORDEN—I couldn't say. I don't know. We have found in our experience that our water has been very bad. It is not exactly gritty, but there is a great deal of volcanic gravel in it, and we find there is absolutely no cutting in the runner, but in the chutes there is considerable cutting which may be due to the gravel.

MR. LIGHTHIPE—That is due to oxidation.

MR. VAN NORDEN—I think it is due to oxidation.

MR. DOBLE—Does that affect the efficiency of the wheel? I understood a while ago that the opening should be a little smaller than the intake. I suppose that is to have an increasing velocity. But if the opening is cut out, doesn't that affect the efficiency of the wheel?

MR. VAN NORDEN—In our experience, we have one or two places where the chutes show considerable pitting, in fact, made a very rough place. This erosion in the chute is probably half or three-quarters of an inch deep. The erosion does not extend to the lower opening of the chute, and the wheel is apparently using the same amount of water, and giving exactly the same amount of power, as when new.

MR. DOBLE—The velocity of the flow through those ports is probably low.

MR. VAN NORDEN—It is low. The area at the discharge end is not over one-sixth or one-seventh what it is at entrance.

MR. DOBLE—Are you familiar with the type of wheel that is installed in the New Milford plant? Is that one of the older types, or of the new?

MR. VAN NORDEN—I don't know, unless it is a Francis type wheel. The Francis type of wheel works very much on this principle, except that the water is brought around the outside of the runner (see Fig. 7), which, being a wheel for a lower head, is supposed to handle an immense amount of water. In order to do that, it has to take the water all around the runner, and the chute box is simply a ring with the chutes cast in it, and they go all the way around. There is cast around the chutes a large pipe, which, as will be seen at *A* in Fig. 8, looks a good deal like a centrifugal pump. The pipe is very large to start with, and gradually reduces in diameter. The water feeds from the outside, into the center of the wheel, and is drawn from there through a draught tube. The efficiency of the Francis wheel is probably as high if not higher than the Girard wheel.

MR. DOBLE—That is the principal point that determined the installation of the turbine, otherwise, the simplicity of the tangential type of wheel would be of no consequence.

MR. VAN NORDEN—The blue prints that I have just passed around (figure 7) show the relative size of a 6000-kilowatt installation for tangential and Francis type water wheel under exactly the same conditions of speed, head and power.

THE SECRETARY—Is there such an installation in existence?

MR. VAN NORDEN—Yes, that shows an existing installation.

MR. HUTTON—I would like to ask Mr. Doble if he ever got any figures on actual bucket efficiency?

MR. DOBLE—If anybody really knew that, it would be very valuable information. Of course, a great many tests have been made, but, unfortunately, nearly every test that is made contains some doubtful element. After they think they have everything else right, perhaps they come to the conclusion that their electrical instruments are defective.

MR. HUTTON—Has any test been made to find out what the windage was? In a very high-speed tangential wheel the windage must be considerable.

MR. DOBLE—That would be charged against the generator, ordinarily, because in close specifications for water-wheel work they guarantee a certain efficiency, or a certain amount of power delivered to the generator.

THE CHAIRMAN—If we have exhausted that subject, the Secretary has a couple of communications that he has received. I will ask that he read them.

The secretary then read the following telegram:

NEW YORK, June 21, 1904.

George P. Low, Secretary Pacific Coast Electric Transmission Association, Monterey, Cal.:

Please convey to the Association my sincere regret at my inability to be present. I wish you all an enjoyable and profitable meeting. H. H. NOBLE.

THE SECRETARY—Although the subject matter is something to be taken up and discussed in executive session, I would also read, as a matter of general information, the following

self-explanatory communication, which was brought about by a letter that I addressed to Mr. H. W. Goode, president of the Portland General Electric Company, and his reply explains not only my letter, but also his action in reference thereto. The letter is as follows:

LEWIS AND CLARK CENTENNIAL EXPOSITION, 1905.
DIRECTOR GENERAL'S OFFICE,
PORTLAND, OR., June 10, 1904.

Mr. George P. Low, Secretary Pacific Coast Electric Transmission Association, 532 Rialto Building, San Francisco, Cal.:

DEAR SIR: In behalf of the Lewis and Clark Centennial Exposition, I have the pleasure of extending to the Pacific Coast Electric Transmission Association a cordial invitation to hold the annual meeting of the Association for 1905 in the city of Portland, Or. In that year will be held at Portland the International Exposition in celebration of the one-hundredth anniversary of the exploration of the Oregon country by Captains Meriwether Lewis and William Clark. The exposition management will be prepared to furnish, without charge, a satisfactory hall for the sessions of the Association, and will, if desired, recognize the Pacific Coast Electric Transmission Association by setting apart a special day or by providing some distinctive feature of the programme.

For your information I inclose a special memorandum concerning the fair, its scope and extent, and exhibit features, which will include subjects of especial interest to your Association.

Very truly yours,
H. W. GOODE,
Director-General.

TUESDAY, JUNE 21, 1904—8 O'CLOCK P. M.

Mr. W. W. Briggs exhibited a number of stereopticon views descriptive of the Pittsburg shops of the Westinghouse Electric and Manufacturing Company.

Mr. Robert McF. Doble read a paper entitled "The Guanajuato Transmission,"* which was profusely illustrated with stereopticon views.

Adjourned until Wednesday morning, June 22, 1904, at 10 o'clock a. m.

WEDNESDAY, JUNE 22, 1904.

(Professor C. L. Cory presiding.)

THE CHAIRMAN—The Convention will please come to order. I think the paper of Mr. Doble read last night would probably lead us naturally to that of Mr. C. A. Copeland on "Medium-Span Line Construction."

MR. COPELAND—It occurred to me that in this paper I have perhaps deprecated the work on the Pacific Coast along this line to a considerable extent. We have lines in California which are more peculiar and better examples of splendid study and engineering in regard to the distributing system than that which the paper outlines, but in it I speak more in a broad sense, that is, looking at the matter from a world-wide standpoint.

(Mr. Copeland read the paper.)†

MR. VAN NORDEN—Mr. Copeland says that in drawing up the lines he did not use any pliers or come-alongs of any kind. How do your arrange that?

MR. COPELAND—I meant on the portion of the cable which is to stand. In pulling up the line to the dead-end point we simply cut out the part of the cable and spliced it over and bound the cable around the insulator and cut the place where we used the come-along. It amounts to the same thing.

MR. LIGHTHIPE—Could you use a twisted rope on that the same as on trolley work?

MR. COPELAND—I presume you could.

MR. LIGHTHIPE—A long twist, ten or fifteen feet?

MR. COPELAND—Yes, it probably could be used, although come-alongs are very much more handy, provided you take care to cut the cable accurately. I might say right there that this line was found to be very easily pulled up, and we measured the sag in one strand and found it exactly the same on all the strands, all the way along the line. It worked much better that way than pulling up ordinary wire.

MR. BABCOCK—How do you pull that up?

MR. COPELAND—Taut.

MR. VAN NORDEN—In pulling up a long strand that way, 36 inches between the wires, do you have any trouble from the wind causing the wires to swing together?

MR. COPELAND—The wires are 45 inches apart, as stated, but even if they were 36 inches apart, I think that there would be absolutely no trouble from that source. I have noticed wire blowing in the wind a great many times, and with wires drawn up to such a tension as obtained in this kind of line, they were not whipping together. I don't think any wind would whip them together.

MR. LEE—In Mr. Copeland's paper the statement is made, "It is believed, but not proved, that stranded copper will not burn off so easily as solid wire on account of its radiating facilities."

About two years ago a very elaborate series of tests was made with aluminum, using both solid and stranded conductors. The arcs were at 40,000 volts. Experimental lines were built, and they used all commercial sizes of copper, that is enough samples to cover the range, and the arcs were started with the wires at different distances apart by means of brush. They could not start an arc with a brush direct, and two wires were tied together with a light fuse, so that the fuse would melt and start the arc across. I believe in every case where there was any wind blowing the arc would travel along the wire, and in the case of solid wire it would leave an even scar right along on the solid conductor; but in the case of strands, where the strands were small, for instance, what you would get on a 19-strand cable, the arc would be sufficient to burn off a strand. In traveling along it would burn off a number of strands, and if the arc, which of course was very vicious, was maintained long enough so that it could travel 15 or 20 feet, the chances are that both strands would be burned, at least the outside strand. The question of radiation did not seem to enter into it; but there is no question that unless you have the strand very large there would be danger in the case of a stranded wire, in the case of a severe arc, whereas in a solid conductor it would merely scar the wire.

MR. LIGHTHIPE—That was at the South Tower of the Carquinez Span. I think the general idea of the reason why the stranded cable burned, both in the case of copper and aluminum, was because they were divided up into small pieces like a bundle of faggots, as against a log of wood; especially so in the case of aluminum, when it once gets heated enough to oxidize itself. The heat is simply terrific. But if you can divide that aluminum up in small enough pieces so it will catch fire from original heat, you are in precisely the same condition as a number of small wooden sticks. Ordinarily one solid stick is hard to light, but if there are a number of small ones the fire starts much quicker. I think it is probably the same case with the oxidation of copper.

MR. LEE—There was one test we made that was particularly interesting. We had erected two large cables of copper

*The paper by Mr. Robert McF. Doble will appear in THE JOURNAL for September, 1904.

†THE JOURNAL, July, 1904, page 201.

and aluminum, of equal conductivity, and the arc was maintained long enough to burn off the cable in both places, that is, so that it sagged down. The wires were reasonably close, so that we could maintain a good arc, and it took 33 seconds to burn off the top of the copper cable and 30 seconds to burn off the aluminum cable. In other words, if you get a good stiff arc it don't make any difference.

MR. COPELAND—I was thinking, in writing this article, of the more common case that we have in Southern California, namely, that of a twig resting peacefully on the wire; when even with ten thousand volts, a sort of jumping or traveling arc was constantly forming, and I had rather an idea that the stranded wire would stand up a little longer than the solid, but now I hardly think that idea is to be borne out.

MR. LEE—If my recollection serves me, on the four-foot separation, it is impossible at 40,000 volts to start an arc with brush or twigs, or even with damp baling rope. In fact, after we passed 30,000 or 40,000 volts the only way we could be sure of getting an arc was by bringing them together electrically with a piece of fuse, and if they started immediately, the fuse went.

MR. HUTTON—I was present when those experiments were made at North Tower, and I think Mr. Lee is wrong in regard to the distances apart and the possibilities of holding those arcs. We had one experiment made with a solid 4-0 wire. The wires were seven feet apart, and we put a branch of eucalyptus across that, and put the current on, and immediately the aluminum began to crack and sparkle, and the arc would start. The minute the fire became continuous between the two wires along the edge of the bark of the limb, the arc would leave the limb and blow along the wire. The wind was blowing strongly at the time and when the arc would be blown out in a loop—sometimes it carried about 14 feet along—it would skip and break and go back to the limb and form and break again. You can keep that up continuously as long as you want to. If there had not been any wind there you could have maintained an arc of seven feet very easily between those 4-0 wires.

MR. LIGHTHIPE—If there was no wind the arc would rise, and if the natural heat was just the same, it would stretch out.

THE CHAIRMAN—Remember that we are here to discuss, if we care to, the paper presented to us last night by Mr. Doble, as well as that presented by Mr. Copeland.

MR. COPELAND—I would like to get further information on the proper sag of copper wire. I suppose there are quite a number here who have studied this matter more than I have, but I have given quite a little time to it. The proper sag of copper wire is an important question. Some figures that I made come out this way: Suppose that the minimum temperatures were 18 degrees Fahrenheit, and the maximum temperature were 138 Fahrenheit; this is of the wire. With ten inches minimum sag, you will see by reference to the table appearing in my paper that the permanent sag becomes quite serious. Assuming a 10-inch sag as the minimum, copper wire at 138 degrees will sag 54 inches. The question is, if you installed this wire at 138 degrees and gave it a 54-inch sag, would it really come up to a 10-inch sag when cold? That is an experiment I have been wanting to try, but have not been able to.

THE CHAIRMAN—Mr. Doble, can you tell us what sag was allowed in the transmission plant in Mexico, and also if you took any particular pains to get the wire up at a certain temperature?

MR. DOBLE—The question of cable was very thoroughly gone into, for under the concession we were required to keep the cable a minimum of seven meters above ground. If the cable were put at a greater height it meant more expensive poles. So that after determining that a forty-foot pole was the most practicable height consistent with economy, we then had to determine the maximum span over level ground. For that purpose it was necessary to very carefully consider what the sag might be under the conditions of maximum temperature, and a great many experiments were made and all authorities were consulted for the best formula for calculating such span. We obtained a great deal of valuable assistance from the Pittsburg Reduction Company—from Mr. Hoops, especially. He very kindly showed us the various methods that he had used for determining sags, and placed at our disposal various formulæ which he had collected. I might say that in this case we made use of one factor in the equation which, so far as I know, had not been used before, and that was what Mr. Hoops termed the release-contraction-curve.

We want to bear in mind that the calculations of a span are a purely mechanical question. We will assume, to start with, that we have a minimum temperature of, say, twenty degrees Fahrenheit, that at that temperature we must not exceed a certain stress per square inch on the cable, and figuring from that at an increased temperature we would have a certain amount of sag; and figuring by the ordinary method, and assuming, as Mr. Hutton said, it was 54 inches, if we omit this factor or release contraction, or the elasticity of the cable, it would not come back to the ten inches, because you must remember that if you have a cable stretched under a given tension, as the cable sags, the elasticity of the cable asserts itself, and it will not sag as much as you calculate by the ordinary method. So you must take into consideration the elastic limit of the wire of which the cable is constructed. That applies more forcibly in a cable than in a solid conductor and perhaps more forcibly in a 19-strand cable than in a 7-strand. It would require considerable experiment to determine this point exactly. We found that the clearance head room under our cable was less in practice than it would have been had we not considered the release contraction, or the elasticity of the cable, and so we went over the calculation very thoroughly. I am sorry to say that I did not think this question would come up, or I might have brought down diagrams and charts. We took into consideration all of the factors that were available or obtainable, and in the case of the 1320-foot span—I might say wherever the topography was such that we could place a tower on high points we did so, and simply made the span accordingly.

In some cases we had 1320-foot spans, giving a sag of something like 60 feet, and the line foreman informed us that he had followed those diagrams, after which he said: "Do you know that when I pulled the cable up the way you said I should, it had just the right amount of sag? I don't see how you fellows figured that out." They pulled it by mule power, but they had the temperature, and the length of the span. The line was carefully surveyed, the profile showed the location of each pole, and knowing the distance and temperature exactly, they pulled it up as closely as practicable to the sag given by the chart—pulling by length and not by tension, for the span lengths were accurately measured.

MR. BABCOCK—The line foreman said that when he pulled according to directions he got the required sag?

MR. DOBLE—He is an old, experienced lineman from the States, and his idea was that he could pull that cable up without using any chart or information or diagrams or anything else, and he said when he pulled it up according to his judgment, and then they checked up on him, he was very much surprised to find that it was about what it ought to be in his opinion.

There is one thing, I think, that we should bear in mind about long spans. The only reason we stopped at 440 feet was because if we had made longer spans our towers

would necessarily have been higher and would have cost more money, but in that climate, which has neither snow nor sleet, there is no reason why we should not make spans of 1,500 feet or even more. It is a mechanical calculation as to what stresses to allow in the cable, because in a longer span you can keep the strain uniform by simply allowing more sag, taking care that you do not get to the point where the wire apprioaches too close to the ground. That is the reason we picked out high points where we could and made long spans. The question of wires swinging together was one that called for considerable debate, and the information obtained was to the effect that nobody knew of wires swinging together. I understand that on the long span across Carquinez Straits, there is wholly a horizontal deflection and that the cables swing practically together.

On the Standard Electric Company's span across the San Joaquin River of some 600 feet, I have been told, I think by Mr. A. C. Bunker, that he had observed them under a gale, and they all seemed to go together; there was no tendency to swing irregularly.

MR. VAN NORDEN—In connection with that, we have, in the Central California plant, a number of spans about 800 to 900 feet. Of course, we do not have the same conditions that Mr. Copeland had, because the spans are across cañons in which we can get any deflection we please. But the spans are all under thick, solid copper, and in putting them up they were figured more from the factor of safety than from the point of deflection. We took into consideration the possibility of wet snow, and figured the greatest wet snow to be a diameter of about six inches, and this gave the factor of safety, with that weight on, of about eight to ten. In doing that, that makes a very heavy deflection for which the catenary is figured, and the next two spans, that is, the next sections from the pole side of the starting span, are figured in the same proportion, so that there is really no strain on the towers that hold the span. We have absolutely no trouble, and have had them loaded with snow. I have seen them swinging, as Mr. Doble says, but they all swing together. We have never had a wire break and have never had any trouble from the span.

MR. DOBLE—I think Mr. Van Norden's explanation is exactly to the point. The sag between the towers will vary in proportion to the distance between the towers. For instance, in once case we had, in going over a hill with two towers 440 feet apart, the sag between them was, I think, about some seven or eight feet. The next span was 1320 feet, and it had a sag of 60 feet. The top of the tower was in a state of equilibrium, and that is a very important point to bear in mind in laying out the system, that your sag must be proportional to the distance apart of supports, assuming that temperature conditions are equal.

MR. VAN NORDEN—I have noticed that all our structures holding spans are very completely guyed against the strain of the span. The guys are invariably loose, and I have never seen them when they were not so, and the span is figured for the lowest temperature we can get. I have never seen any strain on the structure to speak of.

MR. COPELAND—Mr. Doble, what was the installation tension per square inch, in turning those 440-foot spans?

MR. DOBLE—I have not the figures in mind. I think 20,000 pounds to the square inch was the maximum. But the idea was, as Mr. Van Norden suggested, to assume a factor of safety and then calculate everything so as not to exceed that amount; that, of course, depends upon your material. In case of aluminum it would be one thing, and in case of a hard drawn solid conductor, it would be something else, and in case of a stranded conductor, it would be something a little different. But I might say that every transmission line must be very carefully analyzed and calculated according to the material used and the conditions prevailing. Very long spans would not be permissible in a climate where there was much snow and sleet, unless in going across a deep cañon you could give an abnormal amount of sag.

MR. HUTTON—An interesting point comes up in connection with the use of a cable as against solid wire, from the fact that there is some difference in the resistance per given weight. That is on the assumption that the cable is of bar copper, untreated, the surface of which is, perhaps, somewhat oxidized so that there is very little conductivity between the strands. Mr. Lee has very kindly given me some figures from a table which he has, and in the case of a 0000 solid, the weight per mile is 3381 and the resistance per mile .2583, while the stranded is 3405, or 24 pounds heavier per mile, the resistance per mile being the same. That gives us approximately a little less than one per cent. It seems to me I have seen some calculation on the use of quite heavy cables; I think they were for underground work, where the cables were of tinned wire, and if I remember, figuring out the curcular miles of each individual strand and adding them together, it gave a total of a certain number, when with a solid wire of the same number the resistance would be somewhat less. In this case it seemed to be somewhat more. I was wondering whether in the case of wires for transmission it would not pay, perhaps, to tin those wires, like you would galvanize a stranded wire, and get the conductivity between the strand, and thus gain something in the resistance. You would not gain much; if you had 10 per cent. resistance in your line, you would increase, by using plain copper, by one-tenth of one per cent.; perhaps that one-tenth would be gained, and in several thousand horsepower it means considerable.

MR. LIGHTHIPE—Wouldn't you spoil the copper by tinning it? That copper is practically hard copper; it has never been annealed after the last draw.

MR. HUTTON—I question that for this reason: Some time ago I had occasion to use some very strong armature binding wire, and I asked for bronzed tin, and they sent some wire that would be pretty hard to pull through, so it would not hurt it much to tin it.

MR. DOBLE—The tinning might be done on the wire rod of a certain diameter and the reduction would follow after the tinning, and in that way you could get a certain hardness in the effect of the wind I think is infinitely greater than the attraction of gravitation that will make it swing.

MR. HANSCOM—I have worked perhaps twenty or twenty-five telephone wires in a span of about six hundred feet placed about five inches apart. There is considerable sag and I have watched them quite a number of times right on the line with the insulators. They run from a window sill to a pole on top of a building. The wires in swinging seem to maintain their regular distance throughout the length and there is no tendency for them to cross. They have been up four or five years and are pitched about five inches apart.

MR. BABCOCK—What is the length of the span?

MR. HANSCOM—About 600 feet, of soft copper wires with a good deal of sag—about four or five feet.

MR. CONDICT—None seem to have had any experience such as we have had on the Truckee River. We have had a great deal of trouble with wires swinging together. At first we didn't know absolutely that it was the wires swinging together. There were short circuits which could not be located; but we have located three definite cases of their swinging together; therefore, we blame a great many of the others to the same reason.

MR. BABCOCK—What is the separation there?

MR. CONDICT—Thirty inches apart on the ordinary spans, but more on the long spans. We cut two crosses out, and they swung together and stayed together, and one was seen to swing together by the attendants at the power house. It occurred close to the power house. That is copper wire, No. 4. We may have very queer winds up there—I think we have. It blew the roof off the power house and carried it up the mountain once.

MR. AYLSWORTH—I think you will find after a heavy storm that in almost any telephone exchange the majority of troubles are caused by the wires being swung together. I presume that is due to the wind. We always figure to get them far enough apart so that they could not get together. When two iron wires come together, they immediately twist up. My experience has been along common telephone work.

MR. CORY—I think the point Mr. Lighthipe made is a good one. We have two wires swung together between poles in the shape of a catenary. It is like a pendulum. If you have two pendulums of the same length, they will swing together, but if the two wires are not pulled up so that the center has the same reach, they will swing differently. Nevthe wire.

MR. LIGHTHIPE—Wouldn't you have the same trouble with the oxidation of the tin? It is all "doped up," anyway.

MR. HUTTON—The cable is twisted.

MR. LIGHTHIPE—It is too late. You have lost your hard drawn copper.

MR. HUTTON—Copper melts at 600.

MR. LIGHTHIPE—Copper is gone at 600, the hard drawn features of it.

MR. COPELAND—I was going to call attention to the fact that most of the strength of hard drawn wire resides in the skin next to the surface, and as far as I am concerned, I would object seriously to doing anything at all to the wire after it is drawn. Anyway, take a solid stranded cable; the resistance is about one per cent. greater when stranded than it is with the same area solid, and this one per cent., I think some members say, is within the limit of the mechanical purity, one way or the other, of the cable in the first place, anyhow.

MR. LEE—Mr. Blackwell's original calculation and modification form the subject of a paper that is being read to-day in Chicago, and all those who are interested in it will get it in the proceedings of the American Institute of Electrical Engineers.

MR. BABCOCK—One point further in regard to that same paper. I think it is in that paper where they bring up the point of the wires swinging together, and that great distance is necessary on that account. That point is still further discussed in an Italian paper on long-line construction, where they advise putting the wires into a vertical plane with plenty of sag, instead of a horizontal plane. I have watched aluminum in the span, and I have never seen the slightest tendency toward swinging together; the three or four wires have always gone as a whole, and I was rather surprised to see those views advanced. I would like to ask if any of the members have ever noticed any spans swinging, except all together?

MR. LIGHTHIPE—Isn't that due entirely to the fact that with the catenary of the span to make that wire swing like a pendulum, you have simply the force of gravitation to consider and it will swing with a given periodicity naturally? In the case of a gale of wind the pressure on that wire is so much greater than the attraction of gravitation to bring it back to this lowest span, that I don't think the swing is perceptible. If you take three wires in a long span, against twenty-five or thirty not braced, the lateral strain due to ertheless, the force of gravity is sufficient to make that swinging rather small. In regard to Mr. Condit's case, I think it is an instance of extraordinary wind, something like they have in Utah, where they blow freight trains off the track.

MR. HUTTON—If the wind is very high and there are a number of wires on a pole, we all know the pole has to give more or less, and the swinging of the pole may not be in synchronism with the swinging of the wire, which results in a sort of jerking effect. I have seen wires in storms where they did not seem to be swinging, but were jumping and dancing, and they would not all be acting together. In a very long span it would be like a boy swinging in a very long swing, and I think in those long spans we should have the supports pretty well braced sideways. In that way we would perhaps get rid of the swinging of the pole which would tend to interrupt the periodicity of the natural swinging of the wire, whereas, in an ordinary pole line, where the poles are not braced sideways, this synchronous swinging of the wire may be broken up, and in that way you would get motion that would bring the wires together. In the last severe storm in Sacramento, we had a windstorm which reached a rate of 72 miles an hour. We had quite a few crosses, but there were absolutely none on our transmission line.

MR. LEE—An explanation, possibly, of the swinging of telephone wires, and the fact that they swing more than the wires on a power line, might possibly be that the wind strain on a wire is the functional diameter of the wire, whereas the weight of the wire is the function of the square of the wire, and consequently a heavy wire would not swing as much as a light wire.

MR. DOBLE—That is true. The long spans would be much less likely to swing together than a short one.

MR. COPELAND—I am not certain of that now, but I think that the wire function is according to the square of the diameter.

MR. LEE—No; it has a function of two-thirds of the longitudinal cross-section of the strand.

MR. DOBLE—You might call it the projected diameter.

MR. LEE—Yes; isn't it two-thirds?

MR. DOBLE—In that connection, in figuring on the stresses in a long-span cable, you also must take into consideration the resultant of the horizontal stress and the vertical stress. For that reason, on the Guanajuato line, we tried to make some research to determine, if we could, what should be taken as the proper diameter against which to figure the wind stress. My recollection is that after consulting various authorities, which seemed to be at variance with each other, we came to the conclusion to take about two-thirds of the projected diameter.

MR. LEE—That is in accordance with Mr. Lang's investigation.

MR. COPELAND—We have a 500-foot span that I mentioned in the paper, and we gave it a nine-foot sag, with 53 inches between wires. That went through what we call a tornado in the southern part of the State, namely, one of those severe Santa Ana winds. We had no trouble at all. I don't think it is very serious in a long span with high tension in the wire.

THE CHAIRMAN—If there is no further discussion of the paper, the next paper on the programme is by Mr. Hutton, "Some Experiences in the Regulation of a Three-Phase, Four-Wire Mixed Distribution."*

THE CHAIRMAN—That six volts should be understood to be about five per cent. of the actual difference of potential, approximately.

*THE JOURNAL, August, 1904, page 38.

MR. HUTTON—Yes, the voltage being 120.

THE CHAIRMAN—I think we will save time—and we will have to hasten a little bit this morning—if we hear the paper of Mr. Lighthipe now, and discuss the two together.

(Mr. Lighthipe read a paper entitled "The Regulation of Fluctuating Voltage in Transmission Service."*)

MR. LAMME—You don't affect the regulation on the line at Coeur d'Alene by using the regulators?

MR. LIGHTHIPE—You can by installing this regulator on a synchronous motor at Coeur d'Alene—for instance, the Westinghouse synchronous motor at the Tiger Foreman mine, though that synchronous motor, which is of 240 horsepower, may not be large enough to change the power factor enough to keep it even. In fact, one would have to calculate whether we could change the power factor enough with that synchronous motor to make the voltage even. It would probably pay to purchase a synchronous motor and run it empty—letting it float upon the system. This is a subject that Prof. Cory brought up in the mining districts here, when regulation was done by hand.

THE CHAIRMAN—Mr. J. A. Clay is here, from the receiving end of that line. Can you add anything to the paper, Mr. Clay?

MR. J. A. CLAY—Not any more than to mention the effect that the regulator had on the line after it was put in. The service while they had hand voltage regulators at Spokane was decidedly unsatisfactory, on account of the speed regulation of motors. The speed regulation of the compressors, hoists and pumps was of no great consequence, but at the two different concentrating mills they had to maintain the speed almost constant, that is, within at least two or three per cent. If it went beyond that the speed was decidedly unsatisfactory, and their main complaint there was the speed regulation. The lighting load there did not amount to much, because the only town that is lighted now is Wardner. But they noted that every time a motor, especially the 300-horsepower motor in the Hecla hoist in particular, was thrown on the lights at Wardner and at Spokane would at times drop from 115 volts to as low at 90 volts at Wardner, and all the customers there threatening to throw their lights out and go back to the steam lighting plant. They were supplying power from this line, but after the Tirrell regulator came on there was a decided improvement both in voltage and speed, and now you hear no complaint whatever of either voltage regulation or speed regulation. All the mining people up there are decidedly in favor of electric power, especially for milling purposes. I can say that the Tirrell regulator made a decided improvement on speed and voltage regulation on that transmission line.

MR. AYLSWORTH—I would like to ask Mr. Lighthipe, in case a generator runs at 120 r. p. m., with speed varying from 600 to 800 r. p. m., will the regulator take care of the voltage?

MR. LIGHTHIPE—I will mention a case that actually happened at Spokane. They telephoned in from the Coeur d'Alene district that all induction motors and all synchronous motors were running below speed about 20 or 30 per cent., and the voltmeter chart at the power house in Spokane was on its proper point. The voltmeter was exactly right, and they happened to glance at the speed indicator and found it was 30 per cent too low. They went up to the penstock and pulled out a whole lot of driftwood and brought the speed up again, showing that as long as there is speed enough to retain the load, the regulator will hold the voltage.

I would like to bring up another point that Mr. Baum talked about day before yesterday; that is, regarding a steam auxiliary equipment. There are certain times when the steam plant is simply lying idle week after week, waiting for something to happen to the transmission line. Mr. Baum suggested rather a good idea, to have the steam engine coupled, say with a jaw coupling, so as to let the generator end of it float as a synchronous motor, and then put the Tirrell regulator on that to regulate the surrounding districts. The loss of power would simply be the windage and the loss in running the synchronous motor empty, which would not amount to much, but if the motor was large, it would probably hold quite a large area there at practically constant voltage.

MR. HOLBERTON—That Tirrell regulator, probably, is in the power house. You are speaking about the question of the Tirrell regulator on the synchronous motor. Is there any installation of that kind?

MR. LIGHTHIPE—I don't know of any installation of that kind. This question was brought up when I was at Spokane, where Mr. D. L. Huntington, general manager of the Washington Water Power Company, was very enthusiastic over the action of the Tirrell regulator at Spokane, and said if he only had something of this character to take care of the Coeur d'Alene end, he would have a perfect system. We went over various mechanical regulators and we could not find anything that would work quick enough to take care of the Hecla mining hoist. On the way back to Portland, the thought suddenly dawned on my mind, why not put a Tirrell regulator on the synchronous motor at Burke? Mr. Huntington immediately agreed with me that it was the proper thing to do. In fact, he said it would probably pay him to purchase a synchronous motor and use it as a floater up there. The load at Burke is an all-mining load consisting of induction, and synchronous motors and mining hoists. It is a large mining camp, where they probably mine 40 per cent. of the lead ore of the United States, or the lead ore of the world almost, and they are equipping the entire length of this mining camp with electric power.

MR. HOLBERTON—Have you made any calculations as to the size of synchronous motor that will be required for any given condition?

MR. LIGHTHIPE—We are just going into that matter.

MR. H. A. RUSSELL—I recall a motor that was put in for this very purpose of regulation at the Oneida mine, where there was a synchronous motor for regulation at that point, and put in for no other purpose than regulation, and I believe it served its purpose. Afterward they took it out and used it as a motor to get power from. But with a Tirrell regulator in that case they would have had automatic regulation.

MR. CLAY—In the case of the Snoqualmie Falls transmission line from Snoqualmie Falls to Tacoma, the old Tacoma Street Railway Company was running by steam, and as soon as they got the power in from Snoqualmie Falls into Tacoma they put in, I think, a 2000-kilowatt generator, and at the peak of the load they would couple that generator in with Snoqualmie Falls and run in synchronism with them, but during periods of light load they simply cut the generator loose from the transmission line and run it all day as a synchronous motor for regulation at Tacoma. It gave them practically a constant voltage. That was hand regulation. The same results could be accomplished with greater ease, expense and satisfaction by the installation of a Tirrell regulator to be used instead of hand regulation.

PROF. CORY—In this connection I have some data which I discussed with Mr. Lighthipe last night that I thought would be perhaps valuable in connection with this paper. Referring to the synchronous motor of which Mr. Russell

*THE JOURNAL, July, 1904, page 205.

speaks, that motor was put in for this particular reason: At that time the contract between the Standard Electric Company and the Oneida Mine read in such a way that 820 watts were to be considered a horsepower; in other words, allowing the mine a power factor of not less than 92 per cent. By the installation of this floating synchronous motor it was possible for the Onelda Mine to get 820 real watts; in other words, a saving between 746 and 820. It was a mere matter of the synchronous motor paying for itself in about six months, and in addition to that giving them perfect regulation and perfect speed.

Length of line, ninety miles. Cycles, sixty. Voltage, 60,000 at receiving end. Circuit, three No. 0 aluminum wires forty-eight inches apart.

	Line Open No Load	3000 kw. Delivered Power Factor 100 per cent.	3000 kw. Delivered Power Factor 80 per cent. (Lag)	3000 kw. Delivered Power Factor 80 per cent. (Lead)
Load receiving end	.....	3000 kw.	3000 kw.	3000 kw.
Power factor receiving end	.....	100%	80% lag	80% lead
Power factor generating end	1.7%	85.8% lead	99.7% lag	66% lead
Voltage receiving end	60,000	60,000	60,000	60,000
Voltage generating end	58,870	63,073	65,478	60,829
Current from generating station	19.3	34.5	28.7	49.6
Kilowatts lost in line	33.1	236.3	248	451
Efficiency of transmission	.....	92.7%	92.4%	87%
Line loss, per cent. watts	.....	7.1%	7.7%	12.4%
Voltage regulation, per cent.	—2%	4.9%	8.4%	1.4%

The data given in the accompanying table is derived on the basis of a line 90 miles in length; cycles 60, voltage 60,000 at receiving end; aluminum wires 48 inches apart. This is taken under conditions as extreme as can be possible under any circumstances. The quantities appearing in the first column are determined for four different cases; when the line is absolutely open; when we are delivering 3000 kilowatts at 100 per cent. power factor at the receiving end; when we are delivering 3000 kilowatts at a power factor of 80 per cent. lag as well at at 80 lead. Of course, this line has considerable capacity effect. With the line open, which we have already considered in this Association—a condition which must never be allowed if it can be helped—the power factor at the generating end is but 1.7%, and voltage at the receiving end has been kept absolutely constant, which would be an ideal condition, maintained by your Tirrell regulator and the synchronous motor taken together. In that case the voltage at the generating end is less than the voltage at the receiving end with the line open. The charging current is 19.3 amperes, 33 kilowatts lost in the line; regulation in voltage of minus 2%.

The next condition is when you have the 100 per cent. power factor at the load. That produces a power factor of about 86 per cent. at the generating end. The voltage comes up to 63,073, line current 34.5 amperes, which is a combination of the power current and the charging current, and so on. Kilowatts lost in the line, 236.3; efficiency of transmission line, 92.7 per cent.; line loss, 7.1 per cent.; voltage regulation, 4.9 per cent., which is good.

Take a condition which probably exists at Burke over this transmission line; that is 80 per cent. power factor lagging, when you have hoist motors and induction motors. That would give practically unity power factor at the generating station. The voltage at the generating station is 65,478; current on the line, 28.7 amperes, or less than when you have 100 per cent. factor load at the receiving end. Loss in transmission, 240 kilowatts. Efficiency, 92.4 per cent.; line loss, 7.7 per cent. But the voltage regulation is 8.4 per cent.; in other words, about twice as much drop in your line as you would have in the second case—an extremely bad condition of affairs and one which must be prevented. That would give you a power factor at the generating station of only 66 per cent. leading, due to the line capacity of the line and the capacity effect at the load. Sixty thousand volts still at the receiving end, but 829 volts lost in the line—in other words, good regulation as far as voltage is concerned. Current from generating station, 49.6; kilowatts lost in line, 451; efficiency of transmission, 87 per cent.; line loss, 12.4 per cent, but the voltage regulation exceedingly good.

Just one more important point is brought out by these comparative figures. For instance, we have here a line, which would be comparatively bad, so far as voltage variation is concerned, if you did not have something like the Tirrell regulator or a synchronous motor. Sixty-five thousand, four hundred and seventy-eight volts are required at your generating station to keep 60,000 volts at the receiving station, but a loss of only 7.7 per cent. On the other hand, here we have a condition where the voltage regulation automatically would be excellent—only 1.4 per cent. But you are losing—due to the heavy leading current—about 5 per cent. more power in the line in one case than in the other. Five per cent. of 3000 kilowatts would be 150 kilowatts, which, if you were using a water-power station in conjunction with a steam plant and the steam plant making up your difference, would represent per month, at five dollars a horsepower, something like eight hundred dollars. But by getting a combination and keeping the voltage at the receiving end absolutely constant, and having, whatever may be your conditions, the synchronous motor and the Tirrell regulator so adjusted as to give the proper voltage at the generating station, you are not only getting the best possible regulation, but the most efficient transmission possible with that particular line, and at the same time the best possible condition of operation at the generating station, as far as power factor is concerned—a condition which, I take it, is most important, because it is on the dollars' side, in addition to the satisfactory operation. The saving in a water-power transmission, where you have an enormous amount of water, might be of no consequence, but if your oil-burning plant were furnishing the difference, as is the case in Southern California and in Utah, and perhaps in the Bay district, then with the same line under exactly the same conditions, you would not only have the best possible regulation, but at the same time you would save just the same kilowatts as are represented in that per cent. of loss. It is perfectly possible to adapt such an investigation to any line whatsoever.

This happens to be a line corresponding, approximately, to the American River power line, which is about 90 miles long.

MR. LIGHTHIPE—The synchronous motor would throw in lag just as well as in a lead; just as good one side as on the other.

PROF. CORY—Exactly, and with your Tirrell regulator and a synchronous motor, they could be made to work absolutely together and get the best possible result. At the same time, that could be observed at the power house by predetermining for a given power so as to get the most efficient transmission. You have just about as ideal conditions as could be indicated.

One other point. It may be said that in an ordinary case a variation of conditions would change that. The Tirrell regulator in connection with the synchronous motor would take care, as Mr. Clay says, of that very point—a varying load—and I take it that your conditions are so that the load would vary quite materially in power factor as well as in magnitude of load. Isn't that true?

MR. CLAY—That is true. Would it make any difference whether the synchronous motor was empty or loaded?

PROF. CORY—The synchronous motor would have to be of sufficient capacity to produce whatever lagging or leading current might be required, corresponding to the load. Take the Oneida Mine, for instance. I think there was installed there something like 500 horsepower in induction motors. The synchronous motor which was put in at that time, was it not 150 kilowatts?

MR. LIGHTHIPE—One hundred kilowatts, the small one.

MR. CORY—It was 100 kilowatts, which was larger than really needed, but it was at all times capable of producing sufficient current to give unity power factor. At the present time that synchronous motor is driving the compressor under an entirely different contract, which is based on real horsepower, but nevertheless the synchronous motor is giving very constant speed for their concentrators, and at the same time it is certainly a satisfactory thing from the standpoint of the power company.

In large sub-stations, the point that Mr. Baum brought out is good, I think. The importance of that is shown because it would be most remarkable if your engine, turning over, would consume anything like that 5 per cent. which you might save in your line by such a device.

MR. BULLARD—If you used a synchronous motor that was already operating and doing work, you would have to have an added capacity in that synchronous motor to supply the difference, would you not?

PROF. CORY—Yes. To go into that just a little bit, that added capacity is not very great; the difference between, for instance, the altitude of a triangle which would be the capacity-current, and the base line representing the load current is not very great. You can overload your machine only in amperes, in other words.

MR. LIGHTHIPE—In ordering a synchronous motor for this class of work, you could order specially for that purpose, and have it so that you could get a very strong field if you wanted it.

MR. HOLBERTON—What I was driving at was whether anybody had figured on this application of a synchronous motor and then actually done the work and seen it checked up.

PROF. CORY—I don't know of any case where it was actually done, except at the Oneida Mine.

MR. HOLBERTON—In our street railway load we have storage batteries at three different stations.

PROF. CORY—If you could not change conditions, it would be many times advisable to install this extra contrivance.

MR. HOLBERTON—I think we could get along without the extra contrivance.

PROF. CORY—That would be better, if possible.

MR. BABCOCK—I know of one case where a synchronous motor was used in that way. I refer particularly to the Stockton sub-station of the Standard Electric Company. The gas company there had two small synchronous motors. One was 150 kilowatts and the other was about 80 kilowatts, or somewhere near that capacity, or perhaps 120 kilowatts. We had a power factor indicator on the Stockton switchboard—I think it was the first one that was ever used—and we used to watch that and telephone in to the gas company and ask them to change their excitation to suit. We could hold our voltage very close to what we wanted, but it was purely a rule of thumb way of doing it. We did not make any figures, but simply watched the voltmeter, and had them adjust for the best effect.

PROF. CORY—The Tirrell regulator keeps the voltage constant.

MR. BABCOCK—It does that automatically.

MR. LIGHTHIPE—I think most all our lighting plants having synchronous motors are using them for regulating. I think Sacramento used to do a good deal of that.

MR. HUTTON—We had one case where it was necessary to introduce a little leading current in order to keep our voltage up when the Colgate plant was hard pushed to keep up the voltage, and at the same time they were making some changes in such a way that they had to put us on a line where the voltage was not right for us, it was too low. We were drawing quite heavily on the line at that time, and Colgate was short of power, but we had plenty of generator capacity at Folsom which could be used as synchronous motors. Mr. Baum told me to start up a couple of my generators, if my voltage was low, and after I got them in synchronism to turn off the water, keeping them excited. We found that that helped us quite a little. We worked that way a couple of days, but as Colgate was short of power it was a question of using our machinery to improve that condition, and as it made that much extra friction, so it did not help us. But if they had had the power and could have held their speed up, it would show conclusively that it would answer the purpose; it would raise that voltage some ten per cent.

PROF. CORY—We ought to remember that in some cases we don't need a synchronous motor. We have a generator in our power house, driven by an engine. Further than that, as has been already indicated, regulating the voltage also increases the efficiency of transmission, which is a desirable thing.

MR. HOLBERTON—I just happened to notice in glancing at Prof. Cory's figures that the loss in the line is absolutely in direct proportion to the power factor that you have there on the third row, as near as I can get at it.

MR. CORY—Yes.

MR. DOBLE—In reference to the question about whether that synchronous motor can be used for power purposes, I have here the advance copy of an article on synchronous motors for regulation of power factor, by Mr. Lamme, now being read before the Chicago meeting of the Institute. In one of the paragraphs it states, on page 553 of the *Transactions* for May:

"If the synchronous motor can be used for power purposes as well as for regulation, its apparent capacity is increased. This is due to the fact that the regulation is obtained by means of a wattless component, and the power from the energy component, and the algebraic sum of these two is greater than their resultant which fixes the current capacity of the machine."

PROF. CORY—In other words, the synchronous motor might, for instance, in next to the last column, be operated lagging which would actually cut down the current in the synchronous motor, and do the work, making the machine of greater capacity than it would be normally. It would depend on conditions. It might be just the opposite.

MR. VAN NORDEN—We had that condition when we were supplying power for the Alta station and connected in on the Bay Counties line. At a certain time the voltage at the Alta Station was such and the power factor was such that, everything being tied in with the Sacramento lines, our Sacramento voltage was so high that it was practically dangerous to our line. The only way to keep that voltage down was to take all the exciting current, or very near all of it, off the generators in the power houses.

MR. HUTTON—It would be very easy to calculate in a given case, if you had synchronous motors already installed, whether you had capacity enough to take care of a given condition of load. For instance, if you know the power fac-

tor of your load, you know exactly what the current would be for unity power factor, and you would also know what it would be for a given power factor. By drawing suitable functional lines, and letting the hypothenuse be equal to the current which you have, and the horizontal line be the current, the vertical line would give you the amount of current that a synchronous motor would have to carry to balance that load.

PROF. CORY—It is easy to determine the size of motor after you know the line and the load you are working with.

MR. COPELAND—I am glad to hear the "efficiency of transmission" introduced as a regular term. I would further suggest that the term "efficiency of regulation" ought to be a parallel and synonymous term; that is, being simply 100 per cent. minus the figures given here. But the voltage drop has always been considered as a certain percentage of the delivered voltage, and that term, which is used by workmen, seemed to be becoming recognized in electrical engineering. I am glad to see that we have already dropped it and I would further suggest that we get used to that term—"efficiency of voltage," or "voltage efficiency."

MR. CORY—We will add that on there.

THE CHAIRMAN—The Secretary received yesterday from Masson C. Balch a paper which was promised. You will now listen to the reading of the paper, which is entitled, "An 80,000-Volt Experimental Line."

(The secretary then read Mr. Balch's paper.*)

THE CHAIRMAN—Is there any discussion upon this paper of Mr. Balch's? If not, we will listen to the report of the Special Committee on Resuscitation, by Mr. Robert McF. Doble, chairman, including a physical demonstration by Mr. Killick.

MR. DOBLE—You may remember that this committee was appointed about two years ago. Owing to the fact that various members have been absent, and are absent, very little progress has been made. Mr. Hutton has done practically all the work that has been done, and he has taken up the matter by correspondence and made some investigations. I would like to call upon him to report what he has accomplished. We have with us Professor Killick, who is an expert in resuscitation, and after Mr. Hutton has told us what he has learned, we can call upon Mr. Lighthipe and some of the other members who have had practical experience in resuscitating people who have been shocked. I think then a demonstration by Professor Killick will be of value and very instructive to members who may, at some time, be called upon to perform that operation.

MR. HUTTON—About all I have to report is this: I took up by correspondence with the National Electric Light Association the question whether they would allow us to use a paper on the subject of "First Aids and Appliances," which was read by Dr. J. W. McGowan in 1903 before the National Electric Light Association. It has a number of valuable points, and the secretary has sent me twenty-four copies of this paper, which I will be very glad to give the members.

I received some time ago a circular letter from Dr. Francis Carlton of Providence, R. I. It seems that one day a neighbor of Dr. Carlton received a shock from a 2000-volt circuit, and he, by certain means which he explained, resuscitated the man, and it then struck him that it might be a good idea to get up some sort of handy kit that could be used at the power houses and be put on the line wagons, etc.

MR. LIGHTHIPE—I have nothing to add. We all know the case of our Mr. Crawford of Santa Ana Cañon, which has been discussed before in these meetings. He got a shock of about 19,000 volts——

*THE JOURNAL, August 1904, page 228.

THE SECRETARY—If Mr. Lighthipe will permit me to interrupt him, I have a letter here from Mr. Crawford, and also one from Dr. Addison, who was present at the power house during the resuscitation of Mr. Crawford. These I will now read:

FRESNO, CAL., June 18, 1904.

Mr. Geo. P. Low, Secretary Pacific Coast Electric Transmission Association.

DEAR SIR: Answering your inquiry, in the following I will endeavor to state briefly what I know concerning my accident at the Santa Ana power house, where I received a shock of 18,000 volts.

In this power house the primary side of the transformer is connected Y with a grounded neutral. They stand on I beams, embedded in cement, thus effectively grounding the frame.

I was standing on one of these transformers in a stooping position, working with a dead circuit, and on rising to reach a wire on the opposite side of the transformer my head came in contact with the primary lead (bare) to the switchboard from a live bank. The shock threw me back with such force that a gash three inches long was cut in my scalp from falling on the porcelain bushing for the primary lead on the transformer. The points of contact (*i. e.*, both feet and the top of my head) were very badly burned.

L. D. Tandy, of the General Electric Company, was in the power house at the time and began the work of resuscitation on me as soon as I was lifted down from the top of the transformer. He worked over me for forty-five minutes before I drew a breath, and it was nearly an hour longer before I regained consciousness.

At that time I felt no serious nervous shock, nor have I been bothered in that way since. My only discomfort was the pain from the severe burns. It took three months and a skin-grafting operation to heal the burns on my feet. The burn on my head, however, was of a more serious nature. The bone had been destroyed through the middle table for a section about the size of a dollar. After eight months, keeping everything as asceptic as possible, this section was pushed off by the new growth of the bone material formed beneath, and in another three months a skin had formed over the wound and I had no further trouble from it.

This is briefly what I know of my accident, and surely it would prove that promptness and perseverance and a thorough knowledge of the correct procedure are the secrets of success in resuscitation, and that many a poor fellow allowed to die could be saved if his friends had known what they could do for him, and been sure enough not to be discouraged too quickly.

Wishing you a very successful series of meetings, I am, yours respectfully, E. J. CRAWFORD.

(Copy.)

GENERAL ELECTRIC COMPANY,
Principal Office,
Schenectady, N. Y.

SAN FRANCISCO, June 16, 1904.

Geo. P. Low, Secretary Pacific Coast Electric Trans. Association,
532 Rialto Building, City.

DEAR SIR: Yours of the 10th asking me to attend the coming convention of the Transmission Association in the interests of the Special Committee on Resuscitation from Electric Shock, is duly received. Professor McAdie also telephoned me making the same request. I very much regret that I can not attend the meeting of the Association. I leave the city to-night to be absent until after July 4.

As you infer, I was present with Mr. L. D. Tandy, one of our engineers, at the Santa Ana power house when E. J. Crawford received the electric shock which has already become famous. I saw the flash and saw Mr. Crawford fall between two of the large transformers. I assisted pulling him out, and together we began work at once by the ordinary well known means of inducing artificial respiration. I

should say it was several minutes before we could detect any pulse at the wrist and perhaps an hour or more before he could speak. I left him perhaps a couple of hours after the accident and he was brought into town the next morning, when I again saw him. I confess that at the time I had grave doubts as to his recovery. All the rest is probably due to Mr. Crawford's good constitution and his correct manner of living.

Regretting I can not give you more, and with the hope that this meeting of the Association may be unusually successful, and with kindest personal regards, I remain,

Very respectfully yours,

THOS. ADDISON,
Mgr. S. F. Office.

MR. DOBLE—The important part seems to be immediate attention to the respiration. Of course, we should give him such surgical aid as may be required. If a man falls off of a pole, he has something else to be attended to besides the resuscitation. There are surgical cases, fractures, and so on. This paper read by Dr. McGowan is by all odds the most complete and most excellent paper on the subject that I have seen anywhere. It seems to me our members would do very well if they obtained a supply and had them distributed to all of their men who might at any time be called upon to render aid to the injured—not only aid from electric shock or burns, but also aid in ordinary injuries. Frequently men are injured slightly. The Doctor says here: "Owing to the prompt application of first dressings in the late war between the United States and Spain, the records of the surgical department of the army and navy show a smaller percentage of loss of life or limb than in any previous campaign."

This goes to emphasize the importance of immediate attention. In order that the victim shall have immediate attention two things are required: First, that the men working with him shall have at least a rudimentary knowledge of the first aids; secondly, that there shall be at hand some medicine and appliances with which to operate; because, although the doctor must be called as soon as possible, it has happened, I believe, that when the doctor got on the ground he did not have the means to work with.

THE SECRETARY—Where were his hands?

MR. DOBLE—If a kit were carried along with the construction crew, and if kits were provided in the power house, it would undoubtedly be of more than sufficient benefit to offset the cost. I understood from the case that Mr. Lighthipe recounted, I think two years ago, that in his experience he thought that more than one life had been lost by the lack of immediate attention. Did you not, Mr. Lighthipe, at the meeting two years ago, mention the case of a man whom you saw electrocuted on a pole in San Francisco?

MR. LIGHTHIPE—Yes.

MR. DOBLE—Would you mind recounting that?

MR. LIGHTHIPE—That was a case on Mason street, in San Francisco, in which they started to lower a man from the pole—he was a telephone lineman I think—and as soon as they they got him on the curb, a great crowd congregated there, and two policemen kept the crowd back. I tried to get in, with the idea of telling the policemen to start to work on that man immediately; that I didn't believe he was dead. I offered my card, but he shoved me back and told me it was none of my business. I waited there about twenty minutes, and the ambulance wagon came around and they bustled him into the ambulance and carried him off to the hospital, and he was pronounced dead when he got there. In that case there was absolutely no attempt to save that man's life, nor would the policemen allow anybody to attempt it. I brought up the point at that time that the police of the city ought to be instructed in some sort of a way as to first relief to the injured.

THE SECRETARY—I will mention a case that came under my experience a few months ago. I had just got off the Key Route train and had taken the San Pablo car to go up into Oakland, when my attention was called by some children who pointed to a telephone pole and said excitedly, "Look at that man." I looked up and saw a telephone lineman—Dow by name—hanging by one foot in the brace of a cross-arm. There were no power lines on that pole line and evidently a telephone line had become crossed with possibly the 2300-volt star connected Berkeley circuit. After considerable trouble the man was brought down. Quite a crowd gathered shortly, among which was one man who said he had been a lineman. He hesitated to go up at first but finally did so and it was fully twenty minutes before the man was taken down. I say that because a conductor told me that the headway was such that he knew it was twenty minutes from the number of cars which were stopped in front of the pole. In getting him down and in releasing his foot from the brace of the cross-arm he was swung over violently and the back of his head struck a pole step, cutting it severely. He was apparently dead. I could detect no heart action and his breathing was practically suspended. I don't suppose his respiration amounted to over eight of ten a minute. We went to work with the usual method of resuscitation about which I had read and we waited for an ambulance all the while that the men were working over him. No ambulance came, and the driver of a buggy that was there and myself took the man to the receiving hospital. I got in the buggy and the driver struck out through the mud to the receiving hospital nearly forty blocks away, I carrying the man in my arms all the way. We got there at last, hatless, plastered with mud and with a broken buggy, when the hospital attendants worked over him I think about four hours before he became conscious. He recovered fully, despite the fact that the shock went through his frame from hand to hand.

MR. LIGHTHIPE—Didn't you tell me at one time that after the ambulance had been called some officious person countermanded the order and said it was no use, the man was dead?

THE SECRETARY—Some person telephoned to send the morgue wagon, so the ambulance didn't come.

MR. BABCOCK—Mr. Lighthipe suggests that policemen ought to be trained. It has been my experience that some doctors ought to be trained. I had a case where a man was hung up in that way. He was frightfully burned, and after some minutes I succeeded in getting him down. There was no sign of life. The man was dead to all intents and purposes. His muscles were more or less contracted, his body was rigid. It happened that a doctor was driving by in his buggy. The doctor looked at him and said, "Well, it is all off, I guess," and he started to get in his buggy. I called him back and said, "I wish you would try artificial respiration, at least, or something." He said, "The man is dead." I said, "You have no right to say whether the man is dead or not. You have made no examination." He said, "Can't you see that he is dead?" I said, "No, I can't see it, and I wish you would try something." He refused again. I said, "As representative of the Bay Counties Power Company on the ground, I insist that you do something for the man." He said, "The man is dead, and if you want something done for him, get another doctor."

MR. RUSSELL—I have run across several doctors treating electrical burns, men who have been very badly shocked, and I have not run across any of them who knew how to take care of anything of the kind.

MR. DOBLE—Does not that emphasize the importance to the men who are engaged in the transmission business, that they and their subordinates should be taught this very important

matter, that is, to the extent of providing for first aid, and especially until you can get a man into the hands of somebody who does know something about it?

MR. HUTTON—In connection with this I want to say that the secretary of the National Electric Light Association furnished me with twenty-four copies of McGowan's "First Aids" and I think it would be a good idea if all the companies would get sufficient copies of this pamphlet so that they could be given to the doctors in the different cities. Very often in case of accident you can't always get one particular doctor, and if they could be given these pamphlets they would undoubtedly read them, which they, perhaps, have not done at the present time. The secretary in the correspondence told me that we could undoubtedly secure these copies from them—they having the type always set up—for about $15 a thousand, and it seems to me it would be a very good investment for the Association to secure anough of these so that each company could be given several of them, to be quite promiscuously distributed.

MR. LEE—Why not publish them in the transactions? Include them in your report.

THE CHAIRMAN—A motion is in order to have this paper printed, or, perhaps, printed in separate form, so that it might be available independent of the transactions.

MR. DOBLE—I would only add that the usual chart or diagram of the various motions to go through with should be incorporated in that. I think the paper is just a little bit lacking in that respect. My recollection is that a chart was published some time ago by the *Electrical World* that could be added to this.

MR. LIGHTHIPE—I would like to make a suggestion, if it is not imposing on the good nature of the *Journal of Electricity* too much to issue this paper as a supplement. I think it could be circulated all over our Coast pretty thoroughly, and it would be thoroughly appreciated. It is, perhaps, a little extra work.

MR. BABCOCK—It is not possible that anybody can set up the type and turn the thing out as cheap as you can do with these things already done for you. We can buy it at the bare cost of the paper and printing.

MR. LEE—I suggest that while the Association might get these copies and distribute them through the power companies, I think it would be very much better, as the cost of getting several thousand of these papers is so slight, if the Association, as an association, would take the matter up with the State Medical Society, or whatever State society they have—all the practicing physicians, I believe, are registered in the State; if they would take it up in conjunction with that society and distribute them officially to all the doctors. Then we would reach everybody. There is a chance that you might call in a doctor who was not intimately enough connected with the power company, or known well enough to receive a copy. The cost involved is very slight. If the Association's funds would not stand it, the power companies could subscribe.

THE CHAIRMAN—These suggestions could very well be carried out by the appointment of a committee with power to act.

MR. HUTTON—I make a motion that Mr. Lee be appointed as a committee to take up the subject with the State Medical Board, with the idea discussed by him in view.

THE CHAIRMAN—This could be done in conjunction with the regular Committee on Resuscitation which now exists.

THE SECRETARY—The status of the Committee on Resuscitation is that it has no chairman. Mr. McAdie was appointed as chairmman and he was obliged to retire at the last moment. His heart and soul are in this work. I suggest that a report be drafted, and that an exhaustive digest be made of the best methods available, and presented in proper form for publication.

THE CHAIRMAN—What is your pleasure in this matter?

THE SECRETARY—I would suggest that the report had better be referred back to the committee.

MR. DOBLE—I understand that the Secretary's idea is that Professor McAdie should be continued as chairman. I think it is a very excellent suggestion, because Mr. McAdie is a man who is thoroughly competent, and very much in earnest in this matter. Then if it could be arranged that the committee, when it has gathered a little additional data and is ready to act, would go ahead and act without waiting for the next meeting, I think much time would be gained, and I think it would be very well if we could have at least one more member added to this committee. I suggest Mr. Lee.

THE CHAIRMAN—If there is no objection that disposition of the matter will be so ordered and Mr. Lee is added to the committee.

MR. BABCOCK—It happened last year that a man who was employed by me got a slight scratch on his hand from a piece of copper wire and paid no attention to it other than to put a piece of tobacco on it. I have no objection to a man chewing tobacco, but it is a filthy thing to put on an open wound. The net result of his carelessness and foolishness was that he had blood poisoning and nearly lost his hand. The company was sued for pay and medical attendance and so forth, while he was laid up. I would like to impress this upon every man here who has men at work for him. Instruct those fellows when they get a cut or a scratch or a bruise, or anything where the skin is broken, that it is not a thing to be fooled with; that a little bit of care, a little clean boiled water, if they can't get anything else, and dress the thing properly, may save a whole lot of trouble. It does not cost much to have a few antiseptic tablets and dressings handy. You might save yourselves a damage suit.

THE CHAIRMAN—We will hear from Professor Killick, who has been kind enough to come here. Professor Killick is employed by the Equitable Life Insurance Company, and I am sure we would be very glad to have him demonstrate to us the principles of resuscitation. I will have to ask him to do this as expeditiously as possible, because we have two brief papers to consider yet before we adjourn.

THE SECRETARY—The rescuscitation of human life has been Mr. Killick's life work and his life fad, you might say. He has studied the matter extensively in Belgium, Holland, France and Great Britain, as well as on the Atlantic seaboard. It is his hobby. It seems to be the consensus of medical opinion that serious electric shock is an acute form of resuscitation known to Europe for about 130 years. Those trical matters, as he will tell you, but the methods to be pursued in cases of resuscitation from electric shock are along common lines with those that are followed in resuscitation from submersion, from asphyxiation and noxious gases, or anything of that kind. That being the case, it was with great pleasure that I made Professor Killick's acquaintance, and with greater pleasure that I was able to announce that he would give us this demonstration.

PROF. F. H. KILLICK—Mr. Chairman and Gentlemen: This has been an interesting subject with me for the last twenty years. I have traveled through France, Belgium, Holland and England to make research into the old systems of resuscitation known to Europe for about 130 years. Those systems are still in use there for the resuscitation of the apparently dead. For the use of the committee here I am provided with all the codes of rules and regulations taken

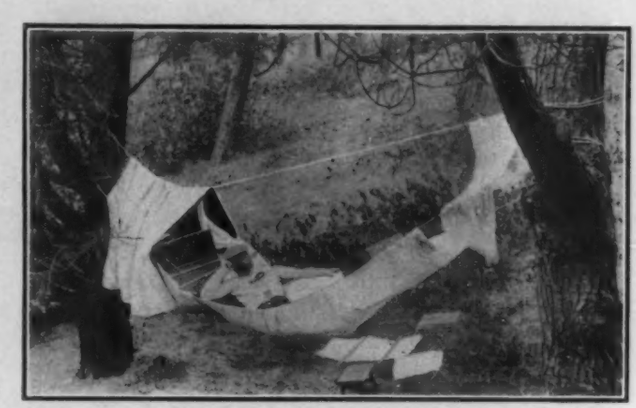
from the walls of the leading life-saving hospitals in Paris, London, Amsterdam and Rotterdam. I am heart and soul with you in this beautiful work of the preservation of human life. I have mastered, in traveling, the systems of Drs. Hall, Sylvester and Howard. They are all good. Many points are to be derived from each one of them, and if time permitted I would have read a paper, but I don't like to detain you gentlemen so near lunch time and we will have to cut it short, and if you will leave the matter for me to assist your committee in any shape or form, you have my full enthusiasm to be with them and work energetically in this direction.

The Royal National Lifeboat and the Royal Humane Society of Great Britain have printed pamphlets distributed to thousands of their men along the coasts of the British Isles, also the lakes and rivers of the interior, and I have brought from London exact duplicates. There are three systems known throughout the world, namely, Drs, Sylvester, Hall and Howard's. Dr. Howard's system I studied in the life-saving stations at Lakes Erie, Huron and Michigan. In these systems the most vital point is the distention of the thorax or ribs, to produce as large an open space as possible for the lungs to be drawn outward and air to enter; pressure made upon the chest exhausts that air, so imitating the action of the diaphragm in life. This is my son, Victor Killick, who has been very useful to me in making demonstrations. I believe in ocular demonstration as being more practical than any other means of education with regard to a matter of this kind. The most important thing in resuscitation is to get your bundle about four inches above the level of the ground, according to the stature, so the thorax will be raised. Let the bundle of towels about four inches in height extend from the center of the shoulder blades downward to the waist, which will distend and open up the ribs, forming a larger space in the lungs than could be produced by any other means. The idea of extending the blanket beyond the shoulder blade will not throw open the ribs so effectually, it rather closes the shoulders inward, instead of letting the shoulders fall backward, as it would be if only extended to the middle of the shoulder blades. The distention of the thorax is one of the most important considerations in resuscitation. As to Dr. Howard's system, it has been proved over and over again that we can get a larger volume of cubic inches of air into the lungs by his system than by Sylvester's or Hall's.

The most important step in resuscitation is to get the respiration started effectually. As the patient lies on the back you will find that the tongue, having no muscular power, will fall over the windpipe and prevent the inlet and exit of the air. The tongue must be brought forward. I have, however, resuscitated a man, being alone, without pulling the tongue forward, on one of my first operations after he was five minutes under water. Many questions have been asked me as to how long a man can remain under water and be brought back to life. I have heard of a case of thirty minutes' submersion, occurring on the River Seine in Paris, France, and had personally two cases of resuscitation after a twenty-minute submersion, in Canada. The longest I have had at the Sutro baths was of five minutes' submersion, the patient being a man of 200 pounds, aged about 40, and afterward enjoyed perfect health. Inside of six months I found him as well as ourselves in appearance. The two patients apparently drowned in Canada, cited above, after remaining twenty minutes under water, were so situated it was impossible to obtain medicine or physicians. Both regained in a short time a normal condition of health.

I have a sample medical case that I obtained from the chief of police in Paris, showing some of the most valuable medicines that I have resorted to. Instead of brandy or whisky, I take aromatic spirits of ammonia, put ten drops in one-eighth of a tumblerful of very hot water, as hot as you can bear it to your own lips. Always test the temperature of the water yourself before giving it to your patient. Afterward, administer same as soon as consciousness, or semi-consciousness, is noticed during the artificial respiration. They used in the olden time feathers if they had no other means of irritating the very sensitive nerves of the nostrils and throat, and those feathers you see in this display on the table.

If a man was struck down in the field, we have here every provision to pick him up at once. Before I start on the resuscitation work I will illustrate a simple method of carrying the wounded or the apparently dead. It is so much so that I don't believe anyone has ever thought of it until I introduced it to many in my travels from Montreal to Victoria and from Seattle to San Diego, lecturing in the public schools. An unbleached piece of muslin, a horse blanket, or anything that is strong enough will do, but I have chosen the lighter material, unbleached muslin, to demonsrate that it is possible with the lightest material to make your stretcher without any unnecessary bundles while traveling. Here we have the branches of trees, chopped or sawed, if you are under an emergency, perhaps twenty miles away from any power house, where you may probably have the provisions for resuscitation. But here we are going to take the most extreme case. We have no medicine or other means to render assistance to the apparently dead. We take two sticks



THE KILLICK HAMMOCK-STRETCHER

of an inch in diameter. That is perfectly strong enough to carry a man. We take our sheet and throw it open, say five feet square. We take one-third of the sheet and raise it, having the poles dividing the sheet into three thirds. The right one-third we raise over the right pole and put alongside of the left. Take the left third over the left pole, drawing it over to the right. We lay the patient between the poles in the center. If Mr. Doble will kindly act as stretcher-bearer for me for one second, I will have my boy feign the dead, and we will lift him, showing that there is not a stitch sewn or nail used to make the stretcher. This stretcher is made in the shortest period of time. There is no fear of the cloth slipping. I will illustrate that by throwing my son in the air and catching him in this stretcher. You can use your telegraph poles as a support to a hammock or stretcher indicated in these photographs. I would be pleased to give you all the requisitions to supply an emergency room in the ordinary power houses throughout the State, and I would be glad to meet any of your physicians at any time.

I have here a photograph of our emergency room at the Sutro baths. I have never lost a man, out of fourteen cases, requiring resuscitation. My first case was a twenty-minutes' submersion. Every wagon that goes out of your power house should be provided with three blankets, a sheet, a piece of canvas, or anything you like that is equally as strong as un-

bleached muslin, together with 100 feet of sash cord for making a stretcher or hammock, and two dozen towels, necessary in resuscitation.

[Professor Killick here indicated his method of constructing a hammock or stretcher; also the special folding of blankets for immediate use.]

The heat of the body is very important as it will expand the blood in the arteries and veins in the same way that the mercury rises under heat. This should be attended to immediately after the respiration is started; you can't do it before the respiration is effected, but the body can be given friction during resuscitation.

[Here Victor Killick laid upon a blanket thrown on the floor serving as a mattress. A second blanket was quickly unrolled over him, being peculiarly folded for that purpose, showing how comfortably protected a patient might be in a very short time, after which the upper blanket was removed and a bundle of towels four inches high was inserted under the center of the shoulder blades, extending down to a line with the waist. Professor Killick then gave a physical demonstration of the three systems of resuscitation known throughout the world.]

PROF. KILLICK—The towels located under the back have the effect of distending the ribs or thorax. When I press down on the thorax without the towels it simply throws the shoulder blades on the blanket. I want to get the advantage of distending the thorax, but there being no support under the back to distend the ribs, I can't get the pressure upward when I press down. By putting the towels under here, as illustrated, it will have the effect of throwing out the ribs like the arch of a bridge, and allowing a great volume of air to enter the lungs. By pressure on the ribs we throw out that air. Artificial respiration is simply the doing of what the mechanical action of the human body can not do. We take a dozen towels and these are folded in such a position, according to the size of the body, that they may lay as I have indicated previously. Now you notice the distention is just as effectual as my boy has illustrated while making that special effort of respiration. This method of respiration I have successfully applied previous to swimming under water —I have two and a half inch lung capacity—but by throwing my shoulders back previous to inspiration I can swim about fifteen feet further under water than I could if I breathed in the ordinary manner.

By taking that deep inspiration and expiration, I overcharge the blood with oxygen, and therefore, the fuel of the engine—the oxygen in the lungs—surcharges the blood and enables the engine to go further. In Howard's system the best position is to kneel on one knee, one side of the patient, and have the other limb on right side, sole of foot on ground this way. It gives one great leverage, and prevents exhaustion of operator. I have done this work persistently for three hours. Spread the fingers and distribute them over as large a surface at the lower extremity of the thorax. There is greater elasticity to be found here. Place the fingers between each of the cartilages and press down, as here you will find the greatest elasticity. With a child you must use discretion as to the pressure on the lower part of the thorax. If you close your fingers, it brings the pressure to bear on one part and you are more liable to bring about an injury of the ribs. You should bear all the weight that you think is discreet, which will force all the air out.

We will assume that the tongue is fastened. The best means and the simplest means of securing the tongue is a small piece of thread. Put it around three times, carrying the ends around ears and secure back of head. The tongue is a very slippery member of the body, and it would slip with the bare finger. The use of a handkerchief will prevent this. I have been in capsizes. In such instances you have to dispense with assistance. If you get a *broad* band you will find that it will slip off the tongue, in all probability. I use a *narrow* elastic band on my shirt sleeves, and I am never found without it for the last ten years. It does not stop the circulation of the blood. But you will find it is a little harder to adjust. It is very hard to secure the tongue in a living person. In the apparently dead there is no muscular resistance, and consequently it is easier.

As soon as you find the slightest movement of the diaphragm let nature work herself, and be patient. If you find she continues, let her alone. If you apply your pressure just as life is coming back, it is so feeble that the least little work on your part may destroy the good work you have done.

In Dr. Sylvester's method you have the tongue forward and secured. You press the two bent elbows and arms on the thorax the whole length, as far as you can distribute the pressure, and press downward so, with the whole weight of your body, if the patient is strong enough. If it is a child it is different. Draw the arms well back, over the head, and draw them as close as you can without straining, so as to throw out the shoulder blades, in this way, which is inspiration. The bundle is pressing upward when operator is pressing downward, and it ejects every atom of air almost that is in the lungs. This is expiration.

MR. BABCOCK—Would you advise it as fast as that?

MR. KILLICK—Fifteen times a minute. In a very extreme case, where I have had the help of a physician, I have asked him which system of resuscitation he is most familiar with, Hall, Howard or Sylvester. He might say Howard, and might say Sylvester. While he is operating Howard's I would work at the same time with him, Sylvester's system. I have found it very effectual, in the combination of the two systems. Dr. Hall's system does not displace so many cubic inches of air as either Sylvester's or Howard's, but it has the effect, if it is a slight case, of the patient suffering less on recovering. I place the patient in this system on the right side, that the heart may have more freedom. We place the underarm so that the forehead shall roll without grazing on the ground. Roll the body well back from the chest to the right side; throw the upper leg on the inside of the lower or left leg; the body is again rolled over to the chest and pressure made by the palms on the back or shoulder blades, creating an equal pressure from the towels supporting the chest. Then repeat the rolling of the body from the chest to the right side, at the rate of fifteen times a minute. These mechanical movements are so simple that any one can master them, and I believe that a child could resuscitate a child.

MR. DOBLE—Which do you consider the best and most practicable system?

MR. KILLICK—Dr. Howard's, our American system. Dr. Howard's has been proved over and over again. Aromatic spirits of ammonia is used, diluted with hot water in place of brandy, and the pure ammonia, to incite the respiration. Apply ammonia just across the nostril occasionally. It stimulates the heart, and at the same time irritates the nerves. Heat is not to be applied artificially until the respiration has started. If you do so, it throws the blood to the heart before the heart is ready to receive it. If, through too long exposure coagulation of the blood sets in, it is impossible to resuscitate. The resuscitation of the apparently dead is just like a clock temporarily stopped by an earthquake. Of course, if a man's arteries are destroyed it is impossible to bring back life. But if any member of the body is injured there might be a possibility of resuscitation, although that member may have to be amputated later.

THE CHAIRMAN—I am sure we are very grateful to Professor Killick for what he has shown us. It is of very great value and interest.

I would be glad to hear a motion to extend a vote of thanks to the mayor and his wife, and to the citizens of Monterey for the courtesies they have shown us.

Motion to that effect made and carried unanimously.

MR. CLARK—The suggestion was made last night that we invite the people who have been entertaining us here in Monterey to the clambake to-morrow, and reciprocate by entertaining them a little bit.

THE CHAIRMAN—If there is no objection, that will be included as a part of the motion.

Mr. R. W. Van Norden, editor of the Wrinkle Department, acknowledged the receipt of the following communications which he then read:

A SAFETY DEVICE FOR A GRAVITY RAILWAY—BY P. C. BUTTE.

The cars are drawn up an incline by means of an endless chain, which is in operation continuously, the cars being attached and detached automatically. This chain is drawn

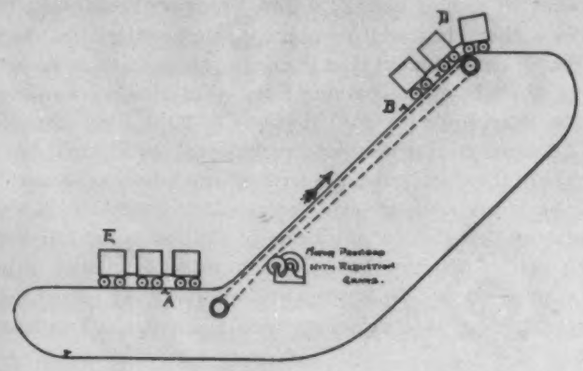


FIG. 1

around by means of a motor specially arranged for the work, as shown in Fig. 1. A number of accidents were caused by collisions between the cars, due to cars *D* stopping before reaching the bottom, and so obstructing the path of cars *E*. The problem was, obviously, to prevent cars *E* from leaving the top of the incline until cars *D* had reached the bottom.

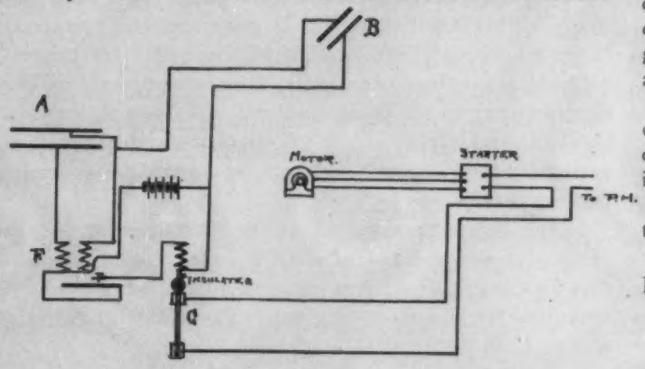


FIG. 2

The safest plan resolved itself into stopping the motor, and this was accomplished as shown in Fig 2.

A represents a section of the rails insulated, shown also in Fig. 1.

B represents a section of the rails insulated near the top of the incline.

F, differential relay, with windings shown.

G, single-pole circuit-breaker having a special winding.

The operation is as follows:

When rails *A* are short-circuited by means of the car trucks, the two windings of the differential relay are in multiple and in opposition, so that when the circuit is closed by means of the cartrucks across tracks *B*, there will be no attraction on the armature of the relay *F*. If, however, the rails *A* should be open, due to the failure of the cars to arrive at their destination at the bottom of the incline, the closing of the circuit at *B* would cause only one of the windings of the relay to be energized, attracting the armature of *F* and in turn closing the circuit through the circuit-breaker coil *G* and the relay contacts. This releases the breaker *G* and stops the cars at *B*.

AN ITEM FROM ENGLAND.

2 NORFOLK ST., STRAND, LONDON, ENGLAND,
June 8, 1904.

DEAR SIR: I am in receipt of a letter from the secretary, Mr. George P. Low, asking for notes, schemes, wrinkles, etc., that have been my lot to come across.

This may not reach you in time for the convention; it makes little difference, inasmuch as this country has never been credited in getting up anything new or startling, and what appears to be new, the origin can always be traced back to the States.

It may interest the members of the Association to know that some of our first-class engineers doubt the idea, or rather the fact, that power can be successfully transmitted a distance of over 200 miles. They tell you that the Americans are noted the world over for telling big stories, and data on the subject is digested with grains of salt. When we make a statement that power could be generated in Liverpool and transmitted to London, a distance of 198 miles, on a commercial basis, they walk away, giving one a hint that you are beyond redemption. Nevertheless, thanks to Yankee enterpise, we will see the day when every main line steam road will be operated electrically, that is, in the British Isles.

Much has lately been done to lessen the labor, expense and time of starting any new project. Formerly it took from two to three years to get a bill through Parliament, and at a terrific cost, whereas now a large number of the obstacles have been removed from the none too easy path of the promoter, making it far less difficult. Another instance which in my opinion is a great drawback to the progress of electrical industries, is England's far-famed Board of Trade. My apologies to the Board of Trade, for with all their regulations they are no better off than we are in the States.

My earnest desire is that this year's convention be the best ever held, and so bristling with new ideas as to repay the engineers for the "midnight watts" which he will consume in digesting the proceedings.

My best wishes to all members of the Association, and may they heartily enjoy themselves.

Very truly yours, E. J. KOPPITZ.

Electrical Engineer for the British Westinghouse E. & Mfg. Co., Ltd.

Adjourned *sine die*.

A simple formula for determining the maximum exciting energy in kilowatts for any given alternator is as follows:

$$\frac{P}{4} + 1\% R$$

where P = number of poles to the alternator and R = rating of the alternator in kilowatts.

The result thus attained, though high, is a good maximum approximation.

Although there are some 2300 electrical undertaking in the British Islands, but twelve of them are driven by water power, and the aggregate capacity of these hydro-electric plants does not exceed 2000 horsepower.

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EDITORIAL.

A WORD TO THE GAS MAN.

As a convention year, 1904 is certainly the best yet, for the attendance at both the Electrical Transmission and the Gas Association meetings was the largest thus far experienced in the annals of either association. Both organizations showed a gratifying increase in membership—that which occurred in the Gas Association amounting to over 30 per cent. of its membership of a year ago. And this, by the way, is the greatest percentage of increase in membership ever attained by any American gas association.

Acquaintance with these organizations leads to at least one interesting anomaly, for while the Gas Association thrives by holding its annual meetings in San Francisco, the Transmission Association has found San Francisco to be, in the vernacular, "a frost" as a convention city. The reason for this probably lies in the fact that as the city by the Golden Gate is an emporium of everything electrical for the transmission man, it possesses distractions of business natures which the attractions of a convention cannot overcome. On the other hand the gas man who comes to attend the annual meeting of his association in San Francisco has but one purpose to his visit, for thus far, at least, the business that he has with San Francisco can apparently be attended to by correspondence as satisfactorily as by his presence there. Perhaps this will be true of the electrical men fifty years hence, but it is not so now.

Then there is another reason why San Francisco, as a convention city, is popular to the one and prejudicial to the other, and this reason is reflected by inference in the remark of a prominent gas engineer whose name is a household word to every member of the Pacific Coast Gas Association, and who upon returning recently from an Eastern trip said: "I am and always have been and always will be a gas man of the blue blood, but I take back everything I have ever said against electrical men. My eyes have been opened and I have found them to be princely in their hospitality, and most liberal in their progressiveness."

Yes, this discloses another reason why electrical conventions do not prosper in San Francisco, the city is too Bohemian and its electrical people are too hospitable, all of which tends to make a side show of the electrical convention held within its gates. But the business of the gas man is apparently not so keenly sought for, and he attends his convention in peace.

Some further thoughts impress themselves upon the one who essays to study these associations both singly and collectively: They pertain to sister sciences and have, in truth, a unity of purpose, but the suggestion of unity of organization, as once proposed, is indefensible; each stands in crying need of a San Francisco headquarters, which they may well combine in supporting; the engineering development that is taking place in their respective fields is along common lines of originality and progressiveness, for the contributions that the long distance high tension transmission systems of California have made to the electrical engineering knowledge of the world, if the truth were known, are paralleled only by the experience that the gas engineers of California are harvesting in the manufacture of gas from crude oil and in its transmission at high pressure over widely separated areas, be they interurban or thickly populated localities.

And right here let there be pointed out a singular weakness in the proceedings of the Gas Association—a weakness constituting a sin of omission rather than of commission: specific description and discussion of methods and appliances used in the manufacture of water gas from crude oil has been consistently shunned by the Pacific Coast Gas Association as though they were unclean. This is not right, for the gas engineering interests of the whole world are looking to California for experience along this line as earnestly and beseechingly as the electrical engineers have, and still are, looking toward California for experience in the operation and behavior of extremely long distance high tension electric power transmission service.

In this connection one is reminded that question No. 17 of the "Question Box" of the Ohio Gas Light Association for 1904, asks: "Are there any plants in successful operation for manufacturing water gas using oil entirely and no solid fuel? Where are they located?"

We of California, where crude oil gas has become a commonplace commodity, and where water gas even has slipped back almost to the level of coal gas in the local fitness of things, at first marvel how such a question can be asked in seriousness, and then, upon reflection, we hang our sinful heads in the knowledge that we have not let our crude oil gas light shine so that all may see it. In this State alone crude oil gas is made in the cities of Oakland, Sacramento, Stockton, Los Angeles, Redding, San Bernardino, San Diego, Bakersfield, Fresno, Hanford, San Jose, Salinas, Monterey, Watsonville, Santa

Cruz, Los Gatos, San Rafael, Redwood City, Santa Rosa, Napa, Colusa, Woodland, Marysville, Chico, Nevada City and Red Bluff. Yet despite this the gas engineers of the outer world who would know of the details of crude oil gas processes have thus far been compelled to swallow the sugar-coated policy of silence which their Pacific Coast confreres have so successfully administered. Let not the Gas Association persist in silence on this all-important topic or it may be branded with the stigma of narrow-mindedness.

From its very advent in the early '80s, when it was regarded as the born enemy of gas, direct and indirect influences of the electrical industry upon the gas business have ever been toward the uplifting of the older form of illuminant from the slough of perhaps bigoted reserve to the exalted plane of a liberal and progressive industry. First came the healthful impetus from keen competition, then followed improvement in old processes due to the necessity for reduced holder costs; next, better relations with the public were cultivated and more liberal policies were adopted and executed in matters of distribution and equitable rates. Old and questionable convictions as to the attitude which gas companies should maintain toward the public were thus slowly found to be fallacious, and in the period of general reconstruction which is gradually following, the electrical practices that had become well and stably grounded were looked to and a new era was instituted in which small economies along every line are being encouraged in both generating and distributing ends; high pressure gas transmission and distribution is being investigated, adapted and perfected in parallel with the well-trodden lines of alternating current practice, until today modern gas plants follow most closely the plans that are characteristic of modern electric station work. Now develops closer and yet closer financial relations between the two interests, so that gradually they are becoming more intimately related as time goes by. This is eminently proper, as these columns have so often preached, and they portend the early arrival of the time when gas and electricity will become recognized as a common industry.

At least three stirling evidences of this progression are found in the papers presented before the recent meeting of the Gas Association. First and most important of these, based on financial and commercial standpoints, is the paper of Mr. Jno. Martin on "Benefits of Consolidation," which is alike instructive to the layman and the corporation manager, and the doctrines of which, when faithfully carried out as they are in the administration of the affairs of the California Gas and Electric Corporation, are the surest antidote to the fever of municipal ownership. Next in importance as indicating the courteous attitude which gas interests are taking for all time before the public, is the paper of Mr. John A. Britton, which discusses the relations existing between the consumer and the gas company "From the Consumer's Standpoint." In truth, the efforts that are now being made toward securing universal contentment between the consumer and the company, as reflected in these two papers, is the direct outgrowth of the policy of fairness long since instituted by the Oakland Gas, Light and Heat Company —that policy of corporate rectitude which should be famed in gas history as "The Oakland Plan."

The third paper meriting distinction along the line of progressiveness and with especial reference to the engineering detail of gas works operation, is that by Mr. C. H. Pennoyer on "Effective Steam Plants for Gas Manufacture," wherein the author concentrates and applies to the gas business the experience gathered during long years of intimate association with the operation of the largest steam-driven electric lighting and power system of the great West. This paper again proves the beneficent influence which the development and comparative perfection of the younger industry is bestowing upon the older one. The gas business has never experienced the fierceness of competition which the electrical business has undergone in its own ranks. Gas men have never known the necessities for securing internal operating and administrating economies that electrical men have been forced to attain, for had they have known them, gas engineering would be on a higher plane of refinement than it is today. Given, then, an engineer who is born and bred in electric station practice, divert his experience to gas manufacture and distribution, and well may you prepare yourself for finding in him a modernizing influence that will be of radical and far-reaching benefit to the gas industry at large.

Space in this issue does not permit further detailed consideration of the remaining gas papers and their discussions, all of which are of great value. Especially important are the able papers on "California Petroleum" by Mr. Paul W. Prutzman, who is evidently a believer in an open-door policy regarding sceintific knowledge, and on "The Labor Problem," by Mr, Frank J. Symmes, whose prominence in financial and business circles and whose devotion to the cause of industrial science make his utterances worthy of mature consideration as being an authoritative presentation of a vital phase of the great problem. Of the remaining papers and their discussions it must at least be said that they are of a very high plane of excellence and that they reflect further lustre on the good name which the Pacific Coast Gas Association bears in the fraternity of engineering societies.

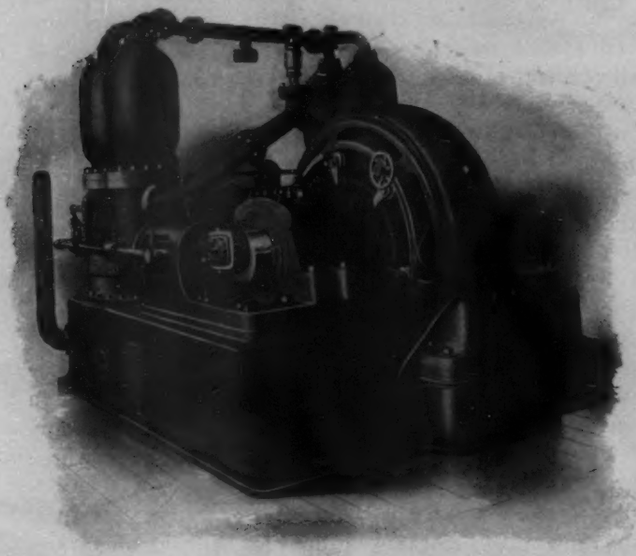
The reader is sure to feel a sense of satisfaction in having the papers and discussions of these two conventions presented to him so promptly. With the exception of the lecture by Robert McF. Doble delivered at Monterey on "The Guanajuato Transmission" all the papers brought before both conventions are concluded in this number of THE JOURNAL, which also concludes the discussions of the papers read at Monterey. In the September number there will be given not only the papers just named, but also the full official report of the gas meeting, which will close the convention period of 1904 so far as the publication of proceedings is concerned.

INDUSTRIAL

A HIGH SPEED MOTOR-DRIVEN PUMP.

THE operation of pumping machinery by electric motors offers, especially in mines, many obvious advantages, such as the centralization of the power plant, elasticity of extension of the system, high efficiency and small first cost and small expense for attendance. Compressed air may be used for the distribution of power to pumps, but it is not usually recommended on account of the low efficiency of the plant as a whole. Small leaks, if many, become serious, and the long line of piping with the numerous joints causes frequent delay, trouble and expense. The use of steam for driving pumps at a distance, and especially in mining operations, is decidedly objectionable on account of the loss by condensation, the heat from the engines and pipes, the extensive piping and the numerous joints liable to leak, as well as to give rise to danger from bursting.

The electric-driven pumps, however, have had one drawback, which, while not serious, has nevertheless to be taken into account. This was the necessity of toothed gearing, belts or other devices to transfer the power from the rapidly revolving motor shaft to the slow moving crank-shaft of the pump. Such devices added to the weight and size of the pumping unit and required



A DIRECT CONNECTED ELECTRIC-DRIVEN PUMP

either careful attention or frequent repairs. The use of toothed gearing on pumps in buildings is, moreover, objectionable on account of noise.

In the pump which is illustrated herewith these objectionable features have been eliminated by the simple expedient of connecting the pump plungers to cranks mounted directly upon the shaft of the motor. This pump has a capacity of about 250 gallons per minute against 1000 feet head when running at a speed of about 300 revolutions. So carefully have the internal parts of the pump been designed, however, that its mechanical efficiency is over 93 per cent., approximating closely that of the highest types of large steam pumping engines. The pump is of the duplex type; the cranks at the opposite ends of the motor-shaft being set at right angles to each other. The plungers are of the outside-packed pattern and the two plungers of each pump are connected by side rods. The plungers are of three and one-half inches in diameter and have a stroke of five and one-half inches. In a very carefully conducted test, the particulars of which are given in the accompanying table, the pump proved a success in every way, surpassing the expectations of the purchasers and even of the builders.

TEST OF BLAKE-KNOWLES HIGH SPEED DUPLEX PUMP, 5½-INCH PLUNGERS, 5½-INCH STROKE, DIRECT CONNECTED TO A GENERAL ELECTRIC, 100 HORSEPOWER, SIX-POLE, 200-VOLT, SHUNT MOTOR.

Revolutions Per Minute.	Motor Input Watts.	Pump		Pump Horse-power.	Motor Pump.	Efficiencies	
		Gallons Delivered.	Pressure Pounds.			Motor Alone.	Pump Alone.
280	28,800	237	110	32.63	78.0%	86.5%	90.1 %
280	40,600	237	215	48.94	82.2%	89.0%	92.36%
280	52,550	235	321	62 25	84.4%	90.1%	93.66%
280	60,200	234	425	74.53	84 3%	90.9%	92.74%
309	58,800	232	496	71.79	83.3%	.....	.....

The volume of the water pumped was measured by means of a carefully constructed and calibrated Freeman nozzle and all gauges were tested before and after the test by means of a weight gauge tester. The pressure at the nozzle was measured by a mercury column connected to a piezometer chamber. Under the greatest pressure the pump showed a remarkably high volumetric efficiency. The operation was practically noiseless under all conditions and was unaccompanied by the slightest shock or heating.

The pump and motor are mounted upon a rigid box-girder frame and the unit is self-contained and occupies a relatively small space. It contains many novel features of construction and the most careful attention has been given to the design of the internal parts, as well as to the running parts and oiling devices. High speed pumps have been connected heretofore with mechanically operated valves, but have proved far from satisfactory, and in many cases the entire valve mechanism has been removed with beneficial results. Some designers advocate closing mechanically both inlet and outlet valves, while others favor mechanically opened valves. The fact is that such complicated mechanisms are useless and lead only to trouble and expense.

This type of pump, which has only lately been introduced, has salient advantages never before attained, including simplicity of construction, small space requirements, cheapness of installation and attendance. The pumps are built by the Blake & Knowles Steam Pump Works, at 114 Liberty Street, New York City, in capacities of from 200 to 4000 gallons per minute and for heads varying from 100 to 2000 feet. One of these pumps operated by a direct-current motor will be exhibited in the space of the General Electric Company at the St Louis Exposition.

The Western Gas Construction Company, through its San Francisco office, has recently duplicated a gas plant at Hanford for the Hanford Gas and Power Company. The plant will have a daily capacity of 80,000 cubic feet The Western company has also just completed a gas plant for The Edison Electric Company, San Pedro, giving an output of 50,000 feet per day.

TWO NEW AGENCIES FOR THE ABNER DOBLE CO.

THE Abner Doble Company has recently secured the Pacific Coast agency for "The Kohler System" for the electric operation and speed control of newspaper printing presses, and during the last week it has closed a contract with the Oregonian Publishing Company, at Portland, Ore., for a fifty horsepower and a ten horsepower Crocker-Wheeler motor, with "The Kohler System" control.

This system is so thoroughly developed that the pressman has entire control of the speed of the press from eight different stations and can start or stop it by means of a push-button. The system is also equipped with a safety switch so that the liability of accident to the pressman is reduced to a minimum.

INDUSTRIAL

The Abner Doble Company has also recently secured the Pacific Coast agency for the Electric Controller and Supply Company, Cleveland, Ohio, manufacturers of the most extensive and complete line of hoist and elevator controllers, crane fittings and lifting magnets that has yet been devised. A great precentage of this class of work requires special apparatus in order to give satisfactory operation, and the great success of the Electric Controller and Supply Company attests the merits of its well known products.

WESTON PATENTS PREVAIL.

A SIGNIFICANT circular has been issued to the trade by The Cutter Company, of Philadelphia, entitled "A Word on the Subject of Measuring Instruments," and reading as follows:

Several years since, the Weston Electrical Instrument Company began a number of suits against other manufacturers for infringements of patents, and it is now possible, from the decisions now handed down, to forecast the net result of these suits with sufficient accuracy. Such decisions as have been reached have invariably been in favor of the Weston Company. A number of suits are still pending, and these, from the evidence already taken, would seem to make it perfectly clear that the Weston Company will ultimately entirely control the electrical instrument business in this country. In our judgment, all of the approved types of measuring instruments, by whomsoever made, are destined to be adjudged infringements of the Weston Patents. This being the case, we felt that it was important for us to put ourselves in a position to supply to our customers, at the best factory price, with all types of Weston measuring instruments, in view of which we will be pleased to send complete catalogue upon request, and discounts on receipt of your requirements.

BROWN-BOVERI A. C. MACHINERY IN AMERICA.

ANNOUNCEMENT is made by the Crocker-Wheeler Company, of Ampere, N. J., that it has concluded an arrangement with Brown, Boveri & Cie., of Baden, Switzerland, by which it has secured their alternating current designs, patents and rights to manufacture in America, and have retained them as consulting engineers. As a result the Crocker-Wheeler Company is now putting on the American market alternating current generators, transformers and accessories of the most perfect design and construction, fully adapted to American practice, and opportunities to bid on this apparatus are invited.

The announcement is further made that the Crocker-Wheeler Company has already closed a contract for a 200 kilowatt 60-cycle, 440-volt, alternating current generator for the Atlanta plant of the Proctor & Gamble Co., Cincinnati, and is figuring on an actively increasing number of alternating propositions.

The Van Emon Engineering Company, San Francisco, is installing eight, thirty horsepower, high speed electric elevators in the Pacific Electric Railway Company's new building at Los Angeles.

The Dunham Carrigan & Hayden Co., San Francisco, has opened a branch store and warehouse in Seattle, in charge of D. E. Erickson. A line of goods for machine shop and the shipping interests will be carried.

The Magnolia Metal Company is establishing a factory on Natoma Street, San Francisco, for the manufacture of bearing metals. The offices of the company will be removed from the Hearst Building to the factory.

The Madison Mercantile Company, San Francisco, has been appointed Pacific Coast sales agent for the Watertown Engine Company, Watertown, N. Y., for the sale of high speed Corliss and automatic engines, and tubular boilers.

PERSONAL.

Mr. W. J. Woodward, vice-president of the National Wood Pipe Company, has succeeded A. Holtgen as manager of the Company, with headquarters in San Francisco. Mr. Holtgen will devote his entire time as manager of the Pacific Tank Company.

Mr. I. Sternfeld, manager of the Mexico City house of Braniff & Co., is on a visit to this country. The company Mr. Sternfeld represents is one of the largest dealers in electrical apparatus in Mexico. The company represents the Westinghouse interests in Mexico.

Mr. A. L. Waterbury, who was at one time first vice-president and general manager of the Citizens' Telephone Company of Houston, Tex., has accepted a position as general manager of the sales department of the American Conduit Company. Mr. Waterbury will have his headquarters at the Chicago office of the company, 1005-6 Manhattan Building.

Dr. Fredrick A. C. Perrine, of Pittsfield, Mass. has resigned his position as first vice-president of the Stanley Electric Manufacturing Company, to be succeeded by Mr. C. C. Chesney, formerly its chief engineer. This step has been taken in order to give him an opportunity to take up his own business and some engineering work along his particular line of power transmission

Dr. Schuyler Skaats Wheeler, president of Crocker-Wheeler Company, electrical manufacturers, sailed from New York on the White Star liner "Baltic." On the pier he said that he had planed a coaching trip in England, but as early this spring Dr. Wheeler went on an automobile tour through the south of France and returned with the American patent rights of the world for the celebrated electrical firm of Brown, Boveri & Cie, of Baden Switzerland, Dr. Wheeler's commercial rivals are beginning to take a lively interest in his holiday trips.

Mr. A. B. Cone, hydro-electric engineer for the Byron Jackson Machine Works, recently returned to San Francisco from a six months' trip in Sonora, Mexico, where he installed a $50,000 hydraulic plant for placer mining. Mr. Cone states that there is considerable activity, along business lines, in the State of Sonora. A number of power and mining companies have been organized and several are in course of organization. Information regarding these companies can be secured from Colonel Francisco Peinado, government representative in Sonora.

Mr. R. M. Jones, the well known electrical engineer, who during the past five years has been in the service of the Pike's Peak Power Company in the capacity of chief engineer and general superintendent, and under whose immediate supervision its hydro-electric transmission plant was installed, announces that he has resigned from the service of the company and is at liberty to engage in the design and installation of hydro-electric plants in the capacity of either consulting or constructing engineer. Mr. Jones' address is now 1455 Josephine St., Denver, Colo.

NEW INCORPORATIONS.

SOUTH BEND, WASH.—The Raymond Light and Water Company; capital stock, $10,000.—*Tacoma Ledger.*

RENO, NEV.—Loyalton Electric Light Company; capital stock, $50,000; incorporators, G. H. Taylor, C. E. Horton, A. N. Horton, B. W. Ward and C. M. Mabel.

FRESNO, CAL.—Thehipite Dome Power Company; capital stock, $75,000; incorporators, C. J. Berry, D. C. Sample, N. C. Caldwell, W. M. Spencer and J. A. Stroud.

SAN FRANCISCO, CAL.—Electric Heater Company; capital stock, $75,000; incorporators, A. C. Swalley, T. C. Maguire, J. A. Davis, H. L. Fearles and E. T. Barrett.

PORTLAND, OR.—The Consolidated Electric Light Company; capital stock, $10,000; incorporators, H. M. Bassford, C. P. Johnson and others.—*Portland Telegram.*

OAKLAND, CAL.—The Century Electric Company, of Alameda County; capital stock, $50,000; incorporators, F. M. Greenwood, S. M. Wood, E. F. Weihe, J. P. Maxwell and R. C. H. Hartley.

LOS ANGELES, CAL.—The Holabird-Reynolds Electric Company, Los Angeles; capital stock, $25,000; incorporators, B. L. Reynolds, A. S. Halstead, E. S. Bailey of Pasadena, R. D. Holabird and C. M. Davis of Los Angeles.—*Los Angeles Times.*

ARTESIA, N. M.—Artesia Telephone Company; capital stock, $25,000; incorporators, Harry W. Hamilton, Samuel P. Downing, James A. Cottingham, of Roswell, N. M. Object, to construct and operate an electric telephone line in Eddy County.—*Roswell Record.*

SANTA ROSA, CAL.—The West Side Telephone Company, Healdsburg; capital stock, $6,000; incorporators, J. McClish, J. B. Wattles, and others. The company will conduct a rural telephone line from Healdsburg connecting the ranches in that section.—*Santa Rosa Republican.*

RENO, NEV.—The J. R. Wright Gravity Motor Company; capital stock, $1,000,000; incorporators, J. R. Wright, of Trenton, Mo.; J. J. Moore, G. A. Hoffman, Chilcothe, Mo., and others. Object, to lease, manufacture and generate any kind of generating or transmitting power.—*Reno Journal.*

REDDING, CAL.—The Bully Hill and Copper City Railway Company; capital stock, $20,000; incorporators, H. A. Cohen, J. B. Keating, J. B. Schoonover and others. Object, to run a steam or electric power road between the Bully Hill Smelter and the Anchor Mine, near Copper City.—*Reading Searchlight.*

SAN FRANCISCO, CAL.—The San Francisco Railway Company; capital stock, $1,500,000; incorporators, J. Walter Scott, W. A. Merralls, A. D. Bowen and others. Object, to construct and operate two street railway lines, one from the ferry building to the ocean beach and the other from the Presidio to the Potrero. —*San Francisco Chronicle.*

LOS ANGELES, CAL.—The Riverside Home Telephone and Telegraph Company, Riverside; capital stock, $500,000; incorporators, J. Van Liew, F. W. Wachter, F. F. Graves and others of River, side. The object is to build a telephone line from Riverside to Carona, to Elsinore via Hemet and Perris, and from Riverside to San Jacinto via Hemet and Elsinore.—*Los Angeles Herald.*

BOISE, IDAHO.—Crane Falls Power and Transportation Company; capital stock, $5,000,000; incorporators, William D. Beam, Thomas J. O'Neill, A. J. Nothacker, of New York; B. F. Olden, George M. Parsons, E. W. Johnsou and L. J. Weaver, of Boise, Idaho. Object, to construct a power plant in Owyhee County, at Crane Falls, for the generation of electric power for the operation of the company's several plants.—*Boise Statesman.*

PORTLAND, OR.—Portland, Salem and West Side Railway Company; capital stock, $500,000; incorporators, Frank Brewster, Robert Balentine and Charles Atherton. Object, to build a main line from Portland, on the West Side, to Salem, a distance of forty-six miles; also a branch line to Hillsboro and a line from Salem to Hillsboro, a distance of fifteen miles. The motive power is to be either electricity or steam.—*Portland Oregonian.*

PORTLAND, OR.—The Mt. Hood Electric Company has been incorporated with $1,000,000 capital stock to generate electricity for commercial use in and about Portland, Or. The company also contemplates installing a trolley line to the base of Mt. Hood. The power will be generated on the Sandy River, about twenty-five miles east of Portland. The incorporators are G. W. Miller and G. W. Waterbury, Portland, and Edwin D. Whitney, Chicago.

OAKLAND CAL.—The Webster Street and Park Railway Company; capital stock, $150,000; incorporators, J. H. MacDonald, C. E. Wilson, T. A. Perkins, Thomas Prather and J. C. Adams. The company will push to completion the Webster Street electric railway, for which a franchise was granted to J. H. MacDonald over a year ago. The line will extend from a point near the water front at the foot of Broadway, Oakland, to the foothills.—*Oakland Enquirer.*

SALINAS, CAL.—The Vantana Power Company; capital stock, $500,000; incorporators, C. P. Bradford, of San Francisco, W. E. Bradford, of San Jose, F. L. Ordway, of Monterey, and others. The company proposes to construct a large dam at the junction of Vanta Creek and the Big Sur River, forty miles south of Monterey, and will generate electricity to be carried to Monterey. It is stated that from 3,000 to 5,000 horsepower can be developed and that work will commence at once.—*San Francisco Examiner.*

EUREKA, CAL.—The Humboldt County Water and Power Company; capital stock, $1,000,000; incorporators, Congressman Gillett, N. H. Hine, F. B. Hink and J. G. Levern. The company intends to take water and power from Mad River, and the plans include a high pressure reservoir between the river and Eureka of sufficient capacity to supply a town of twice Eureka's size with sufficient head to afford great power. The company proposes to install at once a power plant to furnish the immediate market with power and further to bring a supply of good water for domestic uses of the city.—*San Francisco Chronicle.*

SAN FRANCISCO, CAL.—The property owners and residents of the district east of San Bruno Road and north of the county line, unable to secure water from the Spring Valley Company, have formed an independent company for the purpose of supplying the householders of that neighborhood with water. The new corporation is to be known as the Bay Shore Water Company. The water will be obtained from artesian wells, a number of which are being sunk. The new company expects to be able to supply 2350 householders. At present there are over thirty new houses being erected in the district. The tract is on the line of the new bay shore cut-off to be built by the Southern Pacific Company. Over two thousand lots have been sold in this vicinity since a water supply was assured.

SAN FRANCISCO, CAL.—The Bishop-Wilbur Company has been organized by San Francisco men and an application has been made for a charter, with $50,000 capital stock. A temporary organization has been effected, pending the granting of a charter, with Ira Bishop, president, and G. A. Wilbur, general manager. The company has secured quarters at 612 Mission Street, Crossley Building, San Francisco, where it has established an office and sales room. The object of the organization is to sell and install electrical apparatus, machinery and appliances; acting as sales agents for the following well known companies: Warren Electric Manufacturing Company, alternating current generators; Triumph Electric Company, direct current generators and motors; Duncan Electric Manufacturing Company, wattmeters; Jandus Electric Manufacturing Company, arc lamps; Kuhlman transformers, and others.

TRANSPORTATION.

SAN JOSE, CAL.—J. J. Stanfield has been granted an electric railroad franchise in Los Gates, Cal.—*San Jose Mercury.*

LOS ANGELES, CAL.—The Los Angeles Pacific Company is preparing to tear up its tracks at Ocean Park. A third rail will be laid on the Palms cut-off.

OAKLAND, CAL.—The Oakland Transit Company intends to convert the narrow gauge tracks of the Grove Street line, in Oakland, to broad gauge.—*San Francisco Chronicle.*

SAN DIEGO, CAL.—The City Council of San Diego has adopted a resolution granting to E. Bartlett Webster and Ed Fletcher the franchise for an electric street railway in that city.

SALEM, OR.—The new managers of the Citizens' Light and Traction Company will extend the line to Liberty if the co-operation of the residents there can be had.—*Salem Statesman.*

SAN DIEGO, CAL.—An application will shortly be made to the City Council of San Diego for a franchise to extend the lines of the San Diego Electric Railway to Mount Hope cemetery.

SUISUN, CAL.—W. H. Goucher, of San Francisco, is having surveys made in Suisun Valley and along a route leading from Suisun to Vacaville, for an electric railway.—*Suisun Republican.*

VANCOUVER, B. C.—J. Buntzen, general manager of the British Columbia Electric Railway Company, says the electric car sys-

tem will be immediately extended to Greer's Beach, B. C.—*Vancouver Province.*

SEATTLE, WASH.—P. J. Farrely, as trustee, has secured a franchise for the construction and operation of an electric railway from Everett to Skagit County, Washington, in a northerly direction.—*Seattle Bulletin.*

STOCKTON, CAL.—The Supervisors of San Joaquin County have granted H. H. Griffiths a franchise to construct and operate an electric railway along the streets, roads and highways of San Joaquin County.—*Stockton Independent.*

FRESNO, CAL.—The formal transfer of the franchises and rights of way obtained by John Hays Hammond and Harold Wheeler for the Visalia electric car line has been made to the Visalia Electric Railroad Company.—*Fresno Republican.*

LOS ANGELES, CAL.—Chief Engineer Pillsbury, of the Pacific Electric line, states that work on the construction of the Belt Line will be completed as soon as the grading of Columbia Avenue on top of the hill, at Los Angeles, is finished.

CITY OF MEXICO, MEX.—The company owning the electric tramways in Aguas Calientes proposes to extend the lines to Santa Maria, Mex., which will require the construction of several kilometers at a considerable outlay.—*City of Mexico Herald.*

SANTA CRUZ, CAL.—F. S. Granger has purchased the electric railway system at Santa Cruz from James Smith, of New York. The change does not include the Capitola line. The roadbeds of the old line will be improved at once and heavier rails laid.—*San Francisco Examiner.*

TACOMA, WASH.—The Puget Sound Electric Railway Company has made application to the Board of County Commissioners of Pierce County, Wash., for a franchise to construct and operate electric railways and transmit electric power on the streets and roads of the county.—*Tacoma Ledger.*

EVERETT, WASH.—The County Commissioners of Snohomish County, Wash., have granted the trolley franchises asked for by Robert Houston, who is said to represent English capital in the promotion of a trolley system embracing parts of King, Snohomish and Skagit counties.—*Everett Record.*

PORTLAND, OR.—Lester B. French, of Portland, Or., representing Eastern capitalists, proposes to build a double track electric railway between Salem and Portland. Rights of way have been secured over practically all the land along the route between Canemah and Salem.—*Portland Oregonian.*

POINT RICHMOND, CAL.—It is announced that the East Shore and Suburban Company, which is now constructing the electric line in Richmond, will extend its road and form a junction with the Oakland Transit system on San Pablo Avenue, at the Alameda County line.—*Point Richmond Leader.*

SPOKANE, WASH.—Mr. Lunceford, head of the proposed Adams County road, in Washington, says that work will begin at Davenport, Wash. Preliminary surveys are being made from Davenport to Miles for the electric road. Power will be developed at the mouth of the Spokane River.—*Spokane Chronicle.*

SUISUN, CAL.—J. W. Hartzell, of Vallejo, representing the Vallejo, Benicia and Napa Valley Railway Company, has been awarded a franchise, by the Trustees of Suisun, for the construction and maintenance of an electric railway line over certain streets of Suisun, his bid being $25.—*Suisun Republican.*

CHICO, CAL.—F. M. Clough, president of the company which is to build an electric road at Chico, Cal., states that work on the roadbed will be commenced before August 1st. Plans for the road are now in the hands of contractors in San Francisco, who are figuring on proposals for the work.—*Chico Enterprise.*

VANCOUVER, B. C.—The petition of property owners for an extension of the street railway along Cordova Street and on Granville Street, in Vancouver, B. C., has been accepted and agreed to by the City Council, and the British Columbia Electric Railway Company will be requested to extend their lines.—*Vancouver World.*

SAN JOSE, CAL.—The Supervisors of Santa Clara County have adopted the petition of the San Jose, Los Gatos and Interurban Company for a franchise for an electric railroad on Railroad Avenue, in the town of Campbell. The franchise will be offered for sale and bids will be opened on August 2d.—*San Francisco Chronicle.*

CLOVERDALE, CAL.—Alfred D. Bowen, who recently promoted and organized the electric road now building in the southern part of Sonoma County, has had a party of surveyors at work a short distance from Cloverdale with the intention of connecting that town with the Santa Rosa and Petaluma Road at Healdsburg.—*Cloverdale Reveille.*

VANCOUVER, B. C.—A project is on foot to build an electric railway from Hedley, B. C., to Curlew, on the Spokane Falls and Northern Railroad. J. M. Haggerty, of the Similkameen Falls Power and Development Company, and Manager Rogers, of the Nickel Plate Mine, at Hedley, are making negotiations for the construction of the road.—*Vancouver World.*

RENO, NEV.—Over $20,000 in stock has been subscribed by citizens of Reno, Nev., for the construction of a street railway system that will cover Reno and connect with Sparks. The Council of Reno has been asked for a fifty-year franchise. Dr. H. H. Reid and H. J. Darling are members of the committee who have the matter in hand.—*Reno Journal.*

SAN JOSE, CAL.—The directors of the San Jose and Los Gatos Interurban Railway contemplate the construction of two branch lines to connect Los Gatos with Mountain View, and a branch from that line to Stanford University and Palo Alto, and Palo Alto with a short line from Meridian Corners to connect, through Cupertino, with the Los Gatos-Palo Alto line.—*San Jose Mercury.*

SALEM, OR.—Control of the property of the Citizens' Light and Traction Company has been formally assumed by the incorporators of the new company recently organized at Salem, Or. A. Welch, of Baker City, Or., will act as manager. A connecting line is to be built from the asylum to the penitentiary, and many extensions of the railway lines are contemplated.—*Salem Statesman.*

SANTA ROSA, CAL.—The Marin Shore Railroad, recently incorporated at Petaluma, intends to build a railroad about fifteen miles long, to be operated by electric power. The projected road will start at a point in or near San Rafael, thence to and around San Pedro Point, in Marin County, and thence to a point at or near Ignacio. John A. McNear and G. P. McNear are among the directors of the company.—*Santa Rosa Press-Democrat.*

CITY OF MEXICO, MEX.—Owing to the prevalence of "knocking down" among conductors of the railway system of this city, which is estimated to amount to 3 per cent. of the gross receipts, it is proposed to abolish the registers and establish a lottery, having monthly drawings. Capital prize $1000, and numerous smaller prizes. Every passenger to be entitled to a lottery ticket to be furnished by the conductor on payment of fare.

PORTLAND, OR.—W. G. Drowley, of the Baker City Wonder Electric Railway Company, has returned to Baker City, Or., from New York, and states that funds have been secured and contracts signed for the immediate construction of an electric railway from Baker City to John Day, a distance of eighty miles. Major J. W. Bonta, promotor of the project, will arrive in Baker City in a few weeks prepared to begin work.—*Portland Telegram.*

SAN JOSE, CAL.—Property owners of Berryessa, Cal., have given Lockwood & Mehling rights of way for the projected electric railroad from that place to San Jose. The route of the proposed railway is from First Street through the Younger property, coming out almost at the junction of Twelfth Street and the Berryessa road, then out the San Jose and Berryessa road to the town of Berryessa, a total distance of about three and one-quarter miles.—*San Jose Mercury.*

SANTA CRUZ, CAL.—The old Santa Cruz electric car line, which was recently purchased by F. S. Granger, is to be consolidated with the Santa Cruz, Capitola and Watsonville electric car line.

The system will be broadened in Santa Cruz, as new franchises have recently been applied for and more will be asked for. It is understood that F. S. Granger will be general manager, and E. A. Cole, superintendent of the Capitola line, will be operating superintendent.—*San Francisco Chronicle.*

PROVO UTAH.—The Council of Provo' Utah, has passed an ordinance granting a franchise to B. Mahler, Reed Smoot, Jesse Knight, C. E. Lobse, George Havercamp and S. R. Thurman for constructing an interurban railroad through Provo City. Franchises will be asked for from all the municipal corporations in the county and in Salt Lake and Weber Counties, and obtained as rapidly as possible, after which surveys will be made and the actual work of construction will be commenced.—*Salt Lake Deseret News.*

SEBASTOPOL, CAL.—The California Gas and Electric Corporation has given an order to The Electric Storage Battery Company for 164 cells of "Chloride Battery," type 13 G, with tanks of sufficient size for twenty-one type G plates, to be installed in the Sebastopol substation of the Petaluma and Santa Rosa Railway Company. The contract also calls for a regulating booster and the necessary switchboard. This battery will be called upon to regulate the fluctuations in load, thus insuring a constant duty for the motor-generator set, and in time of emergency it will be called upon to take the entire load. The work of its installation is now progressing.

TRANSMISSION.

KALISPELL, MONT.—The Kalispell Lumber Company intends to put in its own electric plant at Kalispell, Mont.—*Kalispell Interlake.*

GRASS VALLEY, CAL.—It is probable that the Nevada County Electric Company will extend its line to Auburn, Cal.—*Grass Valley Union.*

SEATTLE, WASH.—Moran Bros. are completing the installation of a new private 3,0000 horsepower electric plant at Seattle, at a cost of $15,000.—*Seattle Times.*

CITY OF MEXICO, MEX.—D. Carlos Fenelon, Dr. B. W. Wallace and their associates propose to install an electric tramway in the City of Mexico.—*City of Mexico Herald.*

LOS ANGELES, CAL.—In about two months work is to begin on the incline road to be constructed by Colonel Eddy and associates for Mount Hollywood.—*Los Angeles Times.*

VANCOUVER, B. C.—The Council of Ladysmith, B. C., have taken steps for installing an electric light plant there and introducing a telephone system.—*Vancouver Province.*

LOS ANGELES, CAL.—Work on the Euclid Avenue franchise granted to the Los Angeles Railway Company by the Council of Los Angeles, will begin August 1st.—*Los Angeles Times.*

LOS ANGELES, CAL.—It is understood that the Pacific Electric Railway will shortly commence the construction of its large mole at San Pedro, covering forty acres.—*Los Angeles Herald.*

LOS ANGELES, CAL.—Plans are under way by which the Traction Company, of Los Angeles, will extend its line from the present terminus at Terracina to the Bluff.—*Los Angeles Express.*

PORTLAND, OR.—J. P. Nelson has asked the Council of Echo for electric light and water works franchises. If they are granted, work on the plants will begin August 1st.—*Portland Oregonian.*

CITY OF MEXICO, MEX.—Under the direction of J. N. Zermeno, Albert E. Springall, engineer, is making a survey for an electric line between Guadalajara and Chapala, Mexico.—*City of Mexico Herald.*

DALLAS, OR.—J. G. Van Orsdel, the new proprietor of the Dallas electric light plant, at Dallas, Or., is replacing old machinery with new. A new incandescent dynamo will be installed.—*Dallas Observer.*

SALEM, OR.—The Union Light and Power Company will spend $50,000 in improvements at its power plant at Silverton, Or. Cummings, of Seattle, Wash., has charge of the work—*Salem Statesman.*

CHIHUAHUA, MEX.—Dr. A. T. Grove, of Chicago, secretary of the American-Mexico Mining Company, Chihuahua, Mex., states that his company will install an electric power plant.—*Chihuahua Enterprise.*

CITY OF MEXICO, MEX.—Enrique Guerra, of Allende, Coahuila State, Mexico, will at once construct an electric light plant, using water power to generate the current in that town.—*City of Mexico Herald.*

SANTA ANA, CAL.—Garden Grove people are expecting work to begin in a short time on the Pacific Electric line from Los Angeles to Santa Ana, running through Garden Grove.—*Santa Ana Bulletin.*

PORT ANGELES, WASH—The Council of Port Angeles, Wash., has passed a resolution providing for the issuance of $14,000 bonds to continue the work of constructing the electric light system.—*Port Angeles Tribune.*

SAN DIEGO, CAL.—The joint committee of the City Council has recommended to the Counci lof San Diego that a franchise be granted to E. Bartlett Webster and Ed Fletcher for a street railroad.—*San Diego Union.*

LOS ANGELES, CAL.—Some heavy fills in the sand along the proposed new electric railway's beach line, from Playa del Rey to Santa Monica, will delay the opening of the line until the latter part of July.—*Los Angeles Times.*

VERNAL, UTAH—The Lord Bros., from Meeker, have been in Vernal, Utah, recently looking up the prospects for an electric light plant at that place, it is their intention to ask the city for a franchise in the near future.—*Vernal Express.*

CITY OF MEXICO, MEX.—Antonio A. Mott, who has a concession for waters from the Ozolcapan River in Acayucan Canyon, Mexico, is making arrangements to install the necessary plant to generate electricity.—*City of Mexico Herald.*

SANTA CRUZ, CAL.—The petition of the Santa Cruz Street Railway, asking the Council of Santa Cruz, Cal., for a franchise over Front Street, Soquel Avenue and Ocean Street, has been ordered advertised by the Council.—*Santa Cruz Sentinel.*

SONORA, CAL.—Surveys have been commenced by the Tuolumne County Water and Electric Power Company to extend their power line from Jacksonville to Big Oak Flat and Groveland to supply power to the mines in that vicinity.—*Sonora Independent.*

MARSHFIELD, OR.—F. M. Friedberg has sold the Marshfield Light Company, at Marshfield, Or., to C. F. MacKenzie, of Colfax, Wash. It is the intention of the new owner to double the capacity of the plant and make other improvements.—*Marshfield Sun.*

SACRAMENTO, CAL.—Arrangements for the completion of the electric lighting plant at Biggs, Cal., have been completed. The Bay Counties Power Company will erect the pole line from its present line, a mile east of town, to the sub-station.—*Sacramento Bee.*

SACRAMENTO, CAL.—Arrangements for the completion of the electric lighting plant in Biggs, Cal., have been completed. The Bay Counties Power Company will erect the pole line from their present line, a mile east of town, to the substation.—*Sacramento Bee.*

TACOMA, WASH.—Myra B. Hayward has made application to the Commissioners of Pierce County, at Tacoma, for a franchise to erect poles and string wires for the transmission of electricity along the public highways and roads of the county.—*Tacoma Ledger.*

SAN DIEGO, CAL.—General Manager Kennedy of the Edison Electric Light and Power Company of Los Angeles, Cal., will make investigations at San Diego looking to the installation of an electric power and lighting system at that place.—*San Diego Eagle.*

POINT RICHMOND CAL.—The Ericksons have been awarded the contract for grading the boulevard and electric line for the John Nicholl Company, from the Santa Fe Railroad on Richmond Avenue, Point Richmond Cal., to Point Potrero—*Point Richmond Record.*

YERINGTON, NEV.—It is stated that the Government will put in a $40, 000 electric pumping plant at the dam site on the Carson River, in Nevada, as an auxiliary to its big irrigation scheme. This plant will pump water to irrigate 10,000 acres.—*Yerington Times.*

EUREKA, CAL.—The Humboldt Milling Company, of Fortuna, has applied to the Supervisors of Humboldt County for a franchise to extend its power lines to supply Loleta, Rhonerville, Hydesville, Carlotts and Table Bluff with light and power.—*Eureka Standard.*

AMERICAN FORK, UTAH.—The Utah Light and Power Company, of American Fork, has been considering a proposition to light Salt Lake City. It is the intention to erect a plant of about 1000 horsepower about a mile and a half above the present plant.—*Salt Lake News.*

REDDING, CAL.—The Trustees of Redding have awarded to Harry L. Shannon a franchise to construct and maintain a power line and poles throughout the city of Redding for a period of fifty years. Work will be commenced in the near future.—*Redding Free Press.*

SACRAMENTO, CAL.—Promoters of the proposed electric railway from Marysville to Susanville, have filed a notice of location of 15,000 miners inches of the water of the North Fork of Yuba River, the same to be used for generating power to operate the road.—*Sacramento Union.*

STOCKTON, CAL.—H. H. Griffiths has accepted the ordinance passed by the Supervisors of San Joaquin County, which conveys to him franchises for an electric road from Stockton to the Calaveras River on both the Cherokee Lane and the Lower Sacramento road.—*Stockton Independent.*

SAN BERNARDINO, CAL.—It is understood that the Huntington-Hellman syndicate of Los Angeles will construct the electric line which will run from San Bernardino to the mountain resort to be made out of the Smithton ranch, recently purchased by Dr. Baylis.—*San Bernardino Times-Index.*

SAND POINT, IDAHO.—H. M Williams, of Sand Point, announces that contracts have been let in Spokane, Wash., to the amount of about $8,000 for constructing work for the new smelter. The contract for the power house, two miles above the smelter, will be let immediately.—*Sand Point News.*

RIO VISTA, CAL.—T. Leslie De Cew, of the Rush Electric Company, of San Francisco, who is superintending the installation of the electric plant at the cannery at Rio Vista, is now finding out what inducements will be given him to establish an electric light plant in Rio Vista.—*Rio Vista News.*

POINT RICHMOND, CAL.—W. S. Rheem, manager of the East Side and Suburban Railway, has asked the Supervisors of Contra Costa County, Cal., for concessions which show that the company will do extensive building in and about Point Richmond within the next few months.—*Point Richmond Leader.*

SANTA ROSA, CAL.—John A. McNear, president of the Petaluma-Santa Rosa Electric Railway Company, states that a new franchise will probably be asked for both in Santa Rosa and Petaluma for an electric street car system. The franchise recently granted was for a steam road.—*Santa Rosa Press-Democrat.*

SACRAMENTO CAL.—From the location notice filed by Attorney John B. Irish, who represents the promoters of the Downieville-Marysville and Susanville Electric Railroad, that company will have two electric power plants on the Yuba River, one near the mouth of Slate Creek and the other at Bullard's Bar.—*Sacramento Bee.*

LOS ANGELES, CAL.—Officials of the Pacific Electric Company have been at Fullerton recently looking over the surveys for the line. The road, it is said, will be extended from Whittier to Fullerton, Anaheim, Santa Ana and on to the beach, connecting with the line now in course of construction in this county.—*Los Angeles Times.*

SANTA CLARA, CAL.—F. M. Lockwood and J. A. Mehling have petioned the Supervisors of Santa Clara County for a franchise to construct a single track standard gauge electric railroad on the Berryessa road from Milpitas to Capital Avenue, the road to run on a private right of way from Capitol Avenue to Berryessa.—*San Francisco Chronicle.*

EUREKA, CAL.—Manager Barnes, of the Ferndale electric light plant, states that his company has purchased a piece of land a short distance east of town upon which will be erected a new light building. Other improvements are also contemplated by the company, among which will be the furnishing of electric power during the day time.—*Eureka Standard.*

MEDFORD, OR.—The Condon Water and Power Company, of Gold Ray, will soon furnish light and power to Medford. They have made a proposition to the City Council which has been accepted, and their representative, Dr. C. R. Day, has deposited a check for $2500 as guarantee of good faith. It is expected that work will be commenced at once.—*Medford Mail.*

LOS ANGELES, CAL.—Frank H. Massey has been making arrangements with the Edison Electric Light Company, in Los Angeles, to furnish light and power for Lordsburg and La Verne, Cal. Wires will be extended from North Pomona and later to San Dimas. The pumping plant of the Lordsburg water works is to be equipped with electric power.—*Los Angeles Times.*

ANACONDA, MONT.—The Missoula Water Company have been merged into one concern to be known as the Missoula Light and Water Company, of Portland Ore., Joseph Simon, J. M. Gearin and F. R. Olin of Portland are the organizers of the new company. The company contemplates extensive improvements in the light plant at Missoula, Mont., in the near future.—*Anaconda Standard.*

SANTA CRUZ—A project is on foot at Santa Cruz, Cal., to saddle the San Lorenzo River for the purpose of furnishing power for the Co-operative Light Company. The plan is to build a dam above the solid granite ledge just below the big trees. The power houses are to be erected at Rincon Flat, and the water will be carried in a flume from the dam to the power houses.—*San Francisco Call.*

PORTLAND, OR.—G. W. Waterbury, representing Portland capitalists, proposes to utilize the water in the Big Sandy for the purpose of erecting an electric plant, and F. P. Harst of the Molalla Power and Irrigation Ditch Company has taken the right to appropriate from Molalla River water to operate an electric plant to furnish Canby, Hubbard, Woodburn and other valley towns of Oregon with light.—*Portland Oregonian.*

SAN JOSE, CAL.—It is reported that an electric railway will be built on Mount Hamilton. Victor A. Scheller, Joseph H. Rucker, T. C. Barnett and others, have entered into correspondence with topographical engineers and railway experts and have decided that $20,000 will be sufficient for the work of surveys, plans and estimates, and it is their purpose to raise the amount by subscriptions from San Jose people.—*San Francisco Examiner.*

LEWISTON, IDAHO.—A large plant, capable of developing 5,000 to 10,000 horsepower, is to be installed on the Grand Ronde. This power is to be utilized in manufacturing enterprizes in the Lewiston Valley and the Paluse County towns in Idaho. E. H. Libby has organized a company to carry out the plans. The plans provide the installation of a steam plant at Vineland which will provide power until the Grand Ronde plant can be installed. —*Lewiston Tribune.*

SUTTER CREEK, CAL.—General Manager Jackson Dennis, of the Ione and Eastern Railway, has returned to Sutter Creek, Cal., from San Francisco, where he let contracts for the grading, building and equipping of the electric railway from Ione to Jackson and Sutter Creek. The Atlas Contract and Supply Company

of San Francisco has secured all the contracts. The road is to be ready for passsnger traffic by December 5th. Work is to be commenced July 15th.—*Sutter Creek Record.*

GRASS VALLEY, CAL.—Representatives of outside capital have been visiting Kentucky Ridge for the purpose of combining several mines fronting Deer Creek, in Nevada County, Cal., and operating them all under one management. It is claimed that the Niagara dam will furnish generating power for an electric plant that would give electric power to run all the mines. It is inferred that the Halsey and the Reynolds people are back of the new enterprise.—*Grass Valley Union.*

REDDING, CAL.—There is to be another power company in Shasta County if the plans of the promoters do not miscarry. J. E. Frick of Berkeley has appropriated 40,000 inches of water to be taken from Risling River and Crystal Lake, both tributaries of Hat Creek, at a point six miles east of Redding, to be used for creating power. Frick says that San Francisco capitalists are interested with him, that they will form a company, install a plant and run a line down the Sacramento Valley to furnish light and power to many cities and towns.

COMMUNICATION.

ANAHEIM, CAL.—It is reported that the Home Telephone Company will immediately begin construction work at Anaheim, Cal., in accordance with the franchise granted.

SUMPTER, OR.—The Pacific States Telephone Company is arranging to extend its lines from Whitney to the new town of Tipton, Or., a distance of eight miles.—*Sumpter Miner.*

EL PASO, TEX.—The Alamo Telephone Company, of Alamogordo, N. M., is to extend its wires to Weed and will make several connections with ranch houses enroute.—*El Paso Herald.*

VENTURA, CAL.—The Sunset Telephone Company is rebuilding its entire system at Ventura. As soon as the work is completed there, Nordhoff will be looked after and the line extended over into upper Ojai.

LA GRANDE, OR.—Manager Osborn has arranged for the telephone system at La Grande, Or. A common battery and express service will be installed; also a complete new switchboard with automatic service. The improvement will cost about $12,000

MENDOCINO, CAL.—The owners of the Pacific Telephone Company, with lines from Covelo, have determined to extend their system from Sherwood to Laytonville, thus connecting with the new terminal of the California Northwestern Railroad—*Mendocino Beacon.*

SANTA ANA, CAL.—The Supervisors of Orange County, Cal., are advertising for sealed bids for a franchise to construct and maintain telephone and telegraph lines in that county. The bids are to be received by the County Clerk up to 10 a. m., September 7th. —*Santa Ana Blade.*

ANDERSON, CAL.—The managers of the A. & B. Telephone Company report that the proposition made to the Battle Creek people has been accepted, and that the line will be built to a point opposite the fishery and will be known as the Battle Creek extension.—*Anderson News.*

LOS ANGELES, CAL.—L. K. Parks, representing the Home Telephone Company, of Los Angeles, has made application to the Board of Trustees of Fullerton for a telephone system, and the City Attorney has been instructed to prepare notices of sale for a telephone franchise—*Fullerton News.*

LOS ANGELES, CAL.—The Home Telephone Company contemplates extensive additions to its service at Los Angeles. At present a number of agents for electric supply firms from the East are in Los Angeles preparing bids to furnish approximately $1,000,000 worth of material. The bids are for delivery on the Pacific Coast. It is not yet known whether Los Angeles or San Francisco is to be the place of delivery.—*San Francisco Examiner.*

ILLUMINATION.

NEW RIALTO, CAL.—The Rialto Oil and Refining Company completed its plant and made its first run on illuminating oil June 20th. The process employed was worked out by Smith, Emery & Co., San Francisco.

SAN FRANCISCO, CAL.—The Lewiston Gas Company, Lewiston, Idaho, recently organized, is in the market for five carloads of wrought iron pipe. Address W. F. Boardman, 530 Market Street, San Francisco, or W. A. Aldrich, Spokane, Wash.

SAN FRANCISCO, CAL.—The Alaska Codfish Company has placed the order for its power plant at Redwood City Cal., with the Hydraulic Engineering and Supply Company, San Francisco. The order for the lightingplant will be placed later.

SAN FRANCISCO, CAL.—The San Louis Obispo, Cal., Gas and Electric Company has secured the contract from the council to install thirty-five enclosed series arc lights. W. F. Boardman of the company, 530 Market Street, San Francisco, will place the order for the lamps.

SAN FRANCISCO, CAL.—The California Light and Fuel Company has started work on the construction of a crude oil water gas plant at Prescott, Ariz., for the Prescott Electric Company, which will have an output of 100,000 cubic feet of gas per day; Lowe apparatus being used. The company has just completed the installation of two sets of the Lowe crude oil water gas apparatus, together with purifiers, gas holders and general gas works machinery, for the Beaumont Gas Company, Beaumont, Texas, and has completed improvements at the plant of the Tombstone Improvement Company, Tombstone, Arizona, consisting of purifiers and apparatus to increase the production to 60,000 feet per day.

MISCELLANEOUS.

SAN FRANCISCO, CAL.—Thompson Brothers, operating the Eureka Foundry, on Beale Street, San Francisco, have completed the casting of a thirty-inch centrifugal pump for the Boulder Island Reclamation Company. It required seven tons of iron, and was successfully cast in the first trial.

SAN FRANCISCO, CAL.—The Redwood Manufacturing Company, San Francisco, is in receipt of an order from the Lynchburg, Va., water works for twenty miles of thirty inch wooden stave pipe. The company has also landed an order for sixty-inch pipe for a power plant at Cornell University to be used for makiyg tests by the hydraulic engineering department.

SAN FRANCISCO, CAL.—The Lewiston Water and Power Company, Clarkton, Washington, has placed an order for 5,000 high tension insulators (Thomas brand) for operation on a 45,000-volt line, with the California Electrical Works. The company is also supplying the Power, Transit and Light Company, Bakersfield, Cal., with two forty-kilowatt, 10,000-volt American transformers.

SAN FRANCISCO, CAL.—The Wilgus Manufacturing Company, San Francisco, have furnished complete oil burning apparatus for the "Arrow," a boat owned by Hatch Brothers. The apparatus will be installed under 700 horsepower in boilers. The Wilgus Company is also furnishing oil burning appliances to be installed under 300 horse power in Stirling boilers, in the Merchants Exchange.

SAN FRANCISCO, CAL.—The National Wood Pipe Company, Los Angeles and San Francisco, is installing five miles of forty-eight-inch continuous wooden pipe as a conduit for the Washington and Oregon Power Company, Walla Walla, Wash. The installation is, for the most part, for low pressure, but will rise, at points, up to 200 feet. A number of undergraduates of local universities are working on the installation. The National Company is also installing two lines of fifty-two-inch pipe for the Holton Power Company, San Diego County, Cal., on the Colorado desert, fifteen feet below sea level.

SUPPLEMENT TO

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The Twelfth Annual Gas Meeting.

Containing All the Papers Presented Before the Convention of the Pacific Coast Gas Association, San Francisco, July 19-20, 1904.

THE PRESIDENT'S ADDRESS.

BY W. A. ALDRICH.

IT is with very great pleasure that I welcome the members of our Association to this twelfth annual meeting. I am aware that I come among a body of gentlemen not particularly interested in inclined or vertical retorts or charging machinery—owing to the fact that your wonderful State, so prolific in mineral and agricultural resources, now seems to have filled the cup of productiveness to the brim with an almost inexhaustible oil supply—and which to-day is the fuel used generally throughout California for gas making—that I propose rather to address you briefly on the great strides made in the gas industry during the last fifty years, and to give expression to a few thoughts on matters of general interest.

Let us pause, however, to first pay a tribute to the memory of one who has passed away from this world of strife and contention; by the death of Joseph Bryant Crockett, the first and twice president of this Association, we have lost one of the most loyal and devoted of our members. While I do not agree that a gas convention should be turned into a memorial service for the departed—rather let us be encouraged and strengthened in our efforts during life. Considering the great service rendered this Association by our last past president, it is meet that suitable resolutions should be passed and entered in the permanent records of the Association.

I have also received with very great regret the resignation of our late secretary, Mr. J. B. Grimwood, who has faithfully and conscientiously fulfilled the duties of his office since his election July, 1899. Failing health has necessitated him taking a complete rest from business cares. I know I have interpreted your desire in wishing him a speedy return to health and strength. Fortunately for the speaker and this Association, there was a man among us who, notwithstanding the great responsibilities of his official position, was ready as he ever has been, to step into the breach, and now Mr. John A. Britton occupies his old stand as secretary and treasurer, and I congratulate the Association and personally thank him for the sacrifice he has made.

When we consider the fact that fifty years ago there were but thirty gas companies in the United States, the progress made in the gas industry is most extraordinary and only exceeded by the improved methods of manufacture and distribution.

The total capjtalization of all gas companies in 1850 was $6,774,000. At the end of the year 1903 there were 950 gas companies with an issued capital stock of $408,194,753.

Mr. S. N. D. North, chief statistician for manufactures, states that this striking increase in capital is found chiefly in items of machinery, tools, implements and equipments. The number of wage earners having increased from 952 in 1850 to 34,792 at the end of the year 1903. The cost of material increased from $503,074 to $21,605,356, and the by-products from $1,921,746 to $76,516,693.

Still more remarkable is the progress made in heating appliances. I have communicated with nineteen gas stove manufacturers in the United States, requesting statistics on the output of gas ranges, hot plates, heaters and water heaters, with the result that I am able to place before you authoritatively figures which are as extraordinary as gratifying. Up to and including the year 1896 there were approximately 335,000 gas ranges in use. I am unable to give the number sold each year, as I was requested to deal with the statistics as a whole—the information being given confidentially—for the information of this association. From 1899 to 1903 inclusive, the number of gas ranges and other heating appliances sold by nineteen gas range manufacturers were as follows: Gas ranges, 765,909; hot plates, 136,032; heaters, 162,918; water heaters, 38,864.

It has been stated by some of the electrical journals that the march onward of electricity has been so rapid that gas has been relegated to second place and that there are more wage-earners in the electric than in the gas industry. By what extraordinary method of reasoning they have arrived at such an erroneous conclusion, I am at a

loss to understand. The following statistics I obtained from official sources for the year ending 1902. At the time stated there were about 950 gas companies and 3620 electric stations, so that from 2670 towns in the United States we can almost hear the sigh of satisfaction and thankfulness that there are no gas companies in their midst. The 950 gas companies gave employment to 34,792 people, or an average of 36½ per company, and paid in wages $18,752,501, as against 30,226, or an average of 8½ employees per station of our electric friends, or for every employee of an electric plant there are 4¼ em-employees in a gas company.

The issued capital stock of the 950 gas companies amounts to $408,194,753, and which paid in dividends $16,801,351 during the year 1902, as against an issued capital stock of 3620 electric light companies of $372,951,942, on which was paid in dividends $6,187,837 in 1902. In other words, while it is difficult to find a gas company with modern methods not paying fair dividends to investors, out of 3620 electric light companies there were but 589 that dividends were paid on either common or preferred stock. If these facts are not sufficient to show the hallucination our competitors are under, I will give them further food for reflection and call their attention to the advent of the gas arc, of which it may be said, has completely revolutionized store lighting. The speaker has communicated with every gas arc manufacturer of repute in the United States, to whom inquiries were sent for information. In the three years that gas arcs have been before the commercial world there are no loss than 226,000 in use in the United States to-day. The number of gas arcs with an estimated consumption of sixteen cubic feet per hour, burning four hours per day, amount to 5,278,360,000 feet per annum, or more gas than the combined States of Ohio and California used during the year 1902. In this connection I would suggest that with the exception of the inventor of the Welsbach mantle, no man has done so much to stimulate the use of gas for store lighting as has Mr. A. H. Humphrey, the original inventor, whose fame has crossed the seas, as gas arcs are now being used in large quantities in England and Germany, Australia, Mexico and South America. It is safe to assume that of the large number of gas arcs in use, at least 60 per cent., or 135,603, have displaced electric arc lights.

With all the progress that has been made in gas lighting and heating, it is to be regretted that gas for power has not kept apace. As a matter of fact, this important subject has been too long neglected by gas men. There is no doubt whatever that the steam engine has reached its practical limit in the matter of economy and that some other and more economical prime mover will take its place. The gas engine is destined to fill that place. American gas engine manufacturers have awakened to the fact that European manufacturers were making gas engines in large units and shipping them to the United States for use in large manufacturing establishments and for central station use. There is no longer any necessity to send abroad for gas engines in large units. One firm with whom I have been in correspondence informs me that they are prepared to manufacture gas engines for power or any other purpose in units as large as 8000 horsepower in two-crank engines or up to 12,000 horsepower in three-crank engines, guaranteeing any of these engines to drive satisfactorily alternators in multiple. These engines may be built to operate with either natural, producer, coke oven or blast furnace gas, and the manufacturers are prepared to make very strong guarantees covering their satisfactory operation.

There certainly is a great future for the application of the combustion engine for lighting and power work. It may be said that we are now stepping from the reciprocating type of steam engine to the steam turbine. It may perhaps with equal truth be said that we shall ultimately find the steam turbine generally supplemented by the gas engine, and there seems to be no limit to the extent of its application and the development of gas-making processes in connection with it.

Undoubtedly Europe at present is ahead of us, as with their small profit they are required to take prompt advantage of every possible economy. Gas engines are now used very extensively abroad, but America seems to be commencing to take some active interest in the question. The development of processes for making cheap fuel gas has probably been arrested by the rather slow development of the gas engine. Until a few years ago the gas engine was not extensively used except in small sizes, yet to-day it may be said to have fairly reached a point of mechanical excellence which exceeds the best steam engine practice, and applicable to any class of service and in unlimited sizes. The engine is, therefore, perhaps now ahead of the gas-making apparatus development, and it remains for engineers to become better posted on the gas question and the designing of manufacturing apparatus. Then for extended use to introduce the necessary refinements and standards to insure certain results at minimum cost.

The economical use of gas engines as applied to high-pressure fire service has been demonstrated at Philadelphia, where seven 280-horsepower and two 125-horsepower engines, all directly connected to triplex pumps, are now in service for the purpose of furnishing high-pressure fire service to the business district of Philadelphia. The engines are capable of starting from standstill to full speed and load in something like thirty seconds. Of course, in comparison with a steam plant which necessitates steam to be kept up at all times for emergency service, the gas engine has no such standby loss, using no gas except when operated. I suggest it is the duty of all gas managers to familiarize themselves on this most important feature of our profession, as the demand for power is ever increasing.

One of the most important questions that gas companies will be called upon to consider within the near future is the relationship between employer and employee. The

speaker fully realizes that labor has its rights equally with capital. What we do contend for is the inalienable right of a free-born American citizen to sell his labor to whom he pleases and for what remuneration he is willing to accept, with or without the consent of any irresponsible union, trades council or walking delegate. We do not deny the right of any man or organization to cease work whenever he or they so desire, but we do deny his right to prevent another, willing to accept the same conditions, from so doing. It is claimed by so-called labor leaders that the great aim and object of the union is for the betterment of the condition of the workingman, morally, physically and intellectually, and to that end shall receive adequate remuneration in exchange for the fruits of his labor. What are the facts? Take the plumbing business for example, which is more closely identified with the gas industry; experience has proved beyond the shadow of a doubt that the alpha and omega of their doctrine is to perform a minimum of labor for a maximum of wages and then proceed to enforce the doctrine by strikes and boycotts. As an illustration of how far the unions will go, let me take your memories back to that terrible catastrophe in Chicago a few months ago, when the Iroquois Theater was destroyed by fire, resulting in the death of nearly six hundred persons. When the call came for carriages and drivers in order that the bodies might be buried, the order went forth from the unions that the union drivers—who were then on a strike—must not respond to the pleadings of the bereaved to be allowed to bury their dead. It is a fact that they afterward rescinded this order, but only in fear of the nation's wrath. Later in Colorado, within the last two months, a body of non-union men were waiting on the railroad platform in order to take the train to their homes after the day's toil, when an explosion of dynamite occurred directly beneath them, killing fourteen and maiming several others, and this in the name of organized labor. What are you going to do about it? Why can not capital and labor recognize its responsibilties one to the other? I have been in communication with Sir George Livesey, the distinguished engineer and chairman of the South Metropolitan Gas Company of London, who writes me that with the adoption of the copartnership system labor and capital will go hand in hand, each fulfilling his respective part in our modern civilization. Sir George has been identified with the gas profession for more than fifty years. The area supplied by the South Metropolitan Company is fifty-one square miles and the total amount of consumers is 250,677. He has made such a study of the labor question, says Mr. Carroll D. Wright, the United States Commissioner of Labor, that he may be regarded one of the greatest authorities in his line in the world, and his intimate knowledge of the workingman and his character and peculiarities is exceeded by no other employer of labor. At the present time four thousand men are on the pay roll of the company. Briefly, Sir George Livesey's plan is to give the men a direct interest in efficient and economical production by paying them a bonus on their wages, based on the price of gas. One-half of the bonus is required to be invested in the name of three trustees in the company's ordinary stock, until the amount credited to any copartner is sufficient to give him a stock certificate in his own name; the remaining one-half is withdrawable at a week's notice, but may be left in the company's hands to accumulate interest, or it may be invested in stock by the trustees.

The last semi-annual reports, for June, 1903, show that the employees had over a million dollars in stock on deposit and at interest with the company, an average of $250 a man. Summing up, Sir George says: "Employers must work in the direction of partnership with the men; in other words, they must make them partners in their business so as to make them take an interest in their work and achieve the best results for both. The interests of both are identical and not antagonistic, and that both sides ought to recognize."

What copartnership has done for the South Metropolitan Company it can do for any gas company, and I recommend the project to all gas companies throughout the land for their earnest consideration, as a panacea for the evils attending strikes, boycotts, and the lawlessness that necessarily follows, and we trust that Sir George will live to see the day that his plan is adopted generally.

Our Association is rapidly accumulating a valuable gas library which, unlike most libraries of technical associations, is coming into popular use. I notice among the books some of the rarest and most valuable works dealing with our business and its history, and the collection of books as a whole is well equipped with working tools of our craft. The advantages of the free use of this library should not be lost sight of by the members.

The list of papers to be read during this convention is before each member, and reference to them is unnecessary; you will undoubtedly conclude that a veritable feast has been provided which should command and will undoubtedly compel your close attention during the hours provided for the reading and subsequent discussions of same.

I would be lacking in appreciation if I did not at this time tender an expression of my sincere thanks for the great assistance I have received from the officers, and editors of the different departments, and the authors of the various papers, and still again for the great honor conferred upon me as President.

BENEFITS OF CONSOLIDATION AS APPLIED TO SMALL GAS COMPANIES.

BY JNO. MARTIN.

AT the first meeting of the Pacific Coast Gas Association the membership was largely composed of the owners and managers of the smaller gas plants throughout the Coast, each vieing with the other in exchanging experiences then and theretofore encountered in the previous forty years' operation of these plants. The

large majority were then selling gas at from $3.50 to $5 per thousand cubic feet.

I believe that it was at this meeting that a representative of the Welsbach lamp made a display and argued its advantage for use by gas companies as an antidote for incandescent electric lighting, but it was looked upon with marked disfavor. Any device that would give eight times as much light with the same quantity of gas was thought to be undesirable. The members calculated the terrible loss in sales if every consumer would use Welsbachs, and they could see nothing but financial gloom ahead if this monster (?) were encouraged.

In consequence the Welsbach lamp was mentally voted a thing unfit for human gas hands to touch, and thus its general utilization suffered until finally it became absolutely necessary to use it as a measure of self-protection to partially limit the rapid strides of the then despised electric plant and electric lighting.

With this experience in mind, it was almost comical to hear them all testify, at a subsequent meeting a few years later, to the many advantages of this wonderful invention. In fact when the inventor was a subject of discussion they did practically "rise and call him blessed."

To the commercially analytical mind, the matters under general discussion at the earlier meetings carried the conviction that practically all managers of the smaller companies were devoting their time to the careful analysis and understanding of the wrong end of the business, their chief aim being to try to reduce "the cost in the holder."

While little or no consideration was given to matters of distribution, contact with consumers, or aiding or abetting increased consumption in any way, by seeking avenues by which increased consumption might be promoted, it was in nearly every case a condition where the consumer was forced to seek the producer and where the producer deemed it a lowering of his dignity to meet with the consumer and point out to him ways and means by which he might become a larger contributor; extensions of mains were frowned down, and every obstacle put in the way of the purchaser by high prices, charges for meter sets, changes and removals, and the innumerable petty charges that made the old-time gas companies a household curse, and hardly a moment's time was given to the consideration of the advantages of reducing the price of gas one-half, and thereby increase the consumption five or ten fold.

It was this prevailing condition which prompted the writer and his associates to enter the gas field with the belief that aggressive, progressive and sound methods applied to the gas business should produce equally profitable results obtainable in the pursuit of other lines of business.

To have advocated methods and selling prices now prevailing would have been considered absolute "heresy" at that time, and the word "fool" with a few strong adjectives that would have been more expressive than elegant would have been the unanimous expression of the members with reference to any one who could have had the temerity to give utterance to such thoughts. The greatest curse under which the gas men were then laboring could properly be termed "Narrow Prejudice."

The adoption of modern progressive methods with a broad and liberal treatment of patrons and competitors by those now directing the destiny of these companies, has done much to eradicate this curse, and there is hope that there will not be a trace of it left within the next fifty years.

Shortly after entering the gas field, it became apparent that the very brightest minds should be employed to accomplish this commercial revolution. It was, therefore, necessary to acquire a number of these small plants, so that each could have the full measure of the benefits accruing from such an organization at a minimum monthly cost, and capital was freely invested with the full knowledge bought of results in other lines, that good interest would be made on the investment. Old-time prejudice had of necessity to be eradicated in order that the man who held the purse would unloose the strings and the past has proved the judgment of invested capital in promoting gas sales, noticeable in additional revenues, the profits on which have been sufficient to warrant continued investments to produce larger sales; to reduce the price to consumers is to create a demand from the public for our goods.

After the acquisition of a property, the first plan adopted was to lay mains practically everywhere in that town so that the manager was never at a loss for new material to work upon for trade. The generating plants were placed in first-class operative condition, with the best and cheapest method of manufacture.

The public were given many inducements to use gas for fuel, both as to low cost of appliances installed and the price of fuel gas. The patrons were taught how to get the *best results with the least consumption.* This was so different in the old days!

The manager and his men were taught to be civil and polite to consumers —to attend to the troubles first—new business afterward. They were educated to understand that profit comes primarily from large production, thereby insuring larger financial income, and from economies only obtainable as a result of a large output. The office was removed from the dirty, dingy, foul-smelling gas works, to a nice, neatly furnished plate-glass-front store in the center of the town, so that it would be and is a pleasure for the most fastidious patrons to visit the company's office.

In the event of any manufacturing, distributing or commercial problem presenting itself, the manager or employee can obtain satisfactory advice and counsel at once by consulting with those in authority in the respective departments.

The results obtained in each town are comparatively analyzed, and the superior results obtained in any one plant are immediately made operative (conditions permitting) at all the other plants. Small plants whose revenue

or profits would prohibit the employment of engineering talent that would correct faults and errors in manufacture and distribution, have, by consolidation, command not only of the engineering skill but of the managerial, the commercial, the financial and also the accounting end, which by due systematizing, helps all other branches to a complete working out in harmony of plans for the general betterment of all departments. The local manager is of necessity broadened by contact with all of the departments and so a system of general education is produced which widens the horizon of his knowledge and separates him from the narrow environment that follows where he has neither advice to give nor to get.

Thus it will be seen that the greatest advantage of consolidation of small gas companies lies in the fact that the owners are in a position to employ the brightest intellects and apply their efforts to a careful study of the maximum *true* economy permissible with the existing output and what measures to adopt to profitably increase consumption.

By "*true* economy," I wish to use the term as differing vitally from the term "economy," which was frequently used to convey the ideas of owners a decade ago, when the local manager was considered economical because he did all the work, gas-making, gas-fitting, running services, trouble man, collector and bookkeeper (such as he was), and merely called economical because he did not call on the stockholders to put up a few dollars to increase the business. I have in mind such a man, who bought two gas stoves out of his private funds to demonstrate to his doubting stockholders of what advantage they were. It might be interesting to note that at this time in that town (population 4000) over 500 fuel burners are in use.

The type of men who were owners or stockholders in gas companies organized for revenue only is happily passing away, and the successors of them are being educated along the line of greater liberality to themselves and to their patrons, and the efforts of the manager to build up the sales are applauded and awarded, the dispensers of the coin of the realm for betterments, needing only, like the Missourians, "to be shown." Systematic records of accounts, stock on hand, plant operation, maintenance, distribution, construction, installation, mains, services, meters, etc., are absolutely necessary for the proper conduct of such a consolidation. In consequence the managers are taught to be systematic and careful.

I attach herewith a few suggested forms of reports, as an index of how even a small business woven into the warp and woof of a consolidation must and does stand upon the same footing as his larger brothers. The system adopted is extremely simple, and while very complete as to detail, yet it entails no great amount of labor after it is put in operation.

It is good policy to make advancements from the ranks whenever possible, and if some of the employees have not been advanced as rapidly as they might think they deserved, it is only because the opportunity has not presented itself or that he is less proficient in some particular than he knows of. If it is the latter, it might be well for such a manager to carefully analyze his work and dispassionately analyze himself with a view of trying to discover and correct such shotcomings. It is absolutely necessary to avoid "playing favorites" except where such favoritism is based solely on meritorious service.

Another advantage of consolidation is the matter of purchases. This advantage is mainly valuable in reducing the investment cost of betterments and extensions and in the saving to your patrons in the cost of gas appliances, which are usually sold at cost. This latter advantage inures to the company's benefit chiefly through greater sales, resulting in larger consumption of gas, THE COMMODITY upon which you hope to make your profit.

Aside from the benefits heretofore recited of the advantages of consolidation, the large factors are those of concentration of effort centralized in one place, of protection to every company however small, in legal matters, legislation, taxation, insurance reduced to a minimum, based on equitable pro rata basis of administration, elimination of excess of officials, utilization of waste materials in one place from another, all the while retaining in its fullest degree the local coloring in each town, so essential to its proper growth and development.

It is well to remember that increased consumption means reduced cost per thousand cubic feet to the company, and while you may lose money at first by selling gas at $1.50 to $2.00 per thousand, it is only a question of how fast you can increase consumption as to when you can earn a safe 6 per cent. on your investment. By selling gas at a low price, you are also protecting your investment against competition, which is usually fostered and encouraged when high prices prevail.

By consolidation, each plant is relieved from the necessity of earning any stipulated amount on capitalization, for each of the companies has nothing to do with capital; it is simply required to make a showing upon its gross business and is praised or blamed for the economies or waste it practices and the increase or decrease of its business, the fountain head taking care of the financial end, which, being eliminated from the care of the manager, renders him better fitted to look out for the interests committed to his care, he knowing full well that when he can prove the advisability of economical investment it will be made and *well made* for him, so that his burden only is in finding and holding the business that will be profitable.

It should be the aim of every manager to sell gas to every building and to every family in his town, and until then his labors should be unceasing.

"AULD LANG SYNE."

BY T. R. PARKER.

1854.

SAN FRANCISCO.—The matter of writing up a chronological or historical sketch of the birth and progress of the gas-lighting business on the Pacific

Coast has been asked for. Others have been importuned to assist in presenting some things that may have come under their observation in this interesting field of progress, but bashfulness, procrastination, or the briefness of the time allotted has materially interfered (with the exception of a few instances) with anything like complying with such a generous request. It will require the personal exertions of some individual with both time and disposition at his disposal to collect reliable data from existing records to accomplish this very desirable end.

In thinking over affairs on these lines of long ago, the fact of passing years with their accompanying changes was forcibly presented, and familiar faces whose names were then synonymous with the Pacific Coast gas business and in the busy marts of trade, but who are now fast fading from memory into the oblivion of the soon forgotten past. Some of these came up in review, and while thus soliloquizing, the strains of the ever familiar melody, whose first lines begin with "Should auld acquaintances be forgot and *never* brought to mind," were being presented for my entertainment in the home of our mutual friend and frater, E. C. Jones. It suggested itself as a suitable title for this most feeble effort. The names of Adoniram Pierce, of both Donahues, Peter and James; both Eastlands, Joseph and Van Leer; both Beggs, William and James; of J. Mora Moss, Tyler Sabbaton, David E. Knight, Charles W. Simpkins, James Hagen, Gallager of Stockton, J. Q. Brown, Henry Adams, D. Tuthill, Young of Vallejo, Peter B. Fagen, Homer Bloomfield, Peter de Mille, M. J. Elmore and J. B. Crockett, each of whom has joined the innumerable caravan that moves to the pale realms of shade. Memory brings them forth for our consideration. The smiles and frowns of fortune were various with many of them. The future biographer could fill volumes concerning their pluck and energy under adverse or favorable circumstances. W. G. Barrett, Charles E. Burrows, John S. Kaneen, F. H. Eichbaum and possibly J. R. Smedberg, and last but not least, Professor T. S. C. Lowe, still remain, and like leaves in December, are still flickering in the top of the genealogical gas tree waiting for the inevitable blast.

But we will pass from these pleasantries to the things that identified some of them with the Coast field of illumination. A half century has come and gone since Adoniram Pierce constructed a gas works on Jackson street in San Francisco, for the purpose of furnishing gas for Maguire's Opera House and the adjoining properties—an iron retort some five feet long, having a flue cast on it that ran from the back end along on the top to the front, there connecting with the standpipe. It was set horizontally and carbonized about 100 pounds of coal at a charge. The hydraulic main did service as tar-well. A stirabout, or milk of lime purifier, was formed by a puncheon set inside of a larger cask, the intervening space between the two, filled with water, forming the cup or seal for the cover, with an agitating shaft and crank to stir up the lime from the bottom. The condenser, or washer, was composed of a few barrels set on end, tops connected, the inlet in each case having a slight seal. The holder, a small affair was a capacity of about three or four thousand feet, floated in a wooden tank, with a mast running up the center of the holder through the kingpost acting as the guide, this mast being guyed on top with rods to its surroundings. This primitive affair, the first of its kind on the Pacific Coast, did duty, tended by old Paddy Devine, a boiler maker, well known to the early gas men on the Coast, until superseded by the San Francisco Gas Company, this or a similar retort did duty in an experimental bench in the cellar under Billy Beggs' office, corner of First and Howard streets, San Francisco.

So much for the first attempts at gas illumination. To the San Francisco Gas Company belongs the honor of the first manufacture of gas under a franchise on this Coast. The works were started February 11, 1854, and the present year is the semi-centennial, or golden anniversary, of that event, William Beggs of Paterson, N. J., being the superintendent, Peter Donahue president and Joseph G. Eastland secretary. It was a small beginning; a 20,000-foot holder, four purifiers about 6x8 using hydrate of lime (one purifier being off for renewal), and iron retorts, three in a bed, were used, taking a charge of 500 pounds of coal to a setting. A narrative of the evolution of this gas works would, on account of the numerous and rapid changes and happenings, monopolize the entire time allotted to this meeting, so I will endeavor to be brief, avoiding dry details as much as possible.

The construction of larger holders at the old works and at the then new station at Fifth and Howard; new stacks of benches; threes of iron back to back of the old form of H setting; also of fives introducing clays in open settings. About this time J. Mora Moss became president and W. G. Barrett secretary; the purchasing of adjoining properties to provide increased facility for exhaustion, condensation, purification and other necessary betterments became imperative; heavy street main extensions; suction meters were installed to draw gas on the down side of hills, manufactured by Morris Dobzinsky, the pioneer in the meter line on this Coast. The office of inspector was created over gasfitters to see that the pipes were tested, and runs of proper sizes put in buildings and executed in a workmanlike manner. Mr. David M. Marshall filled this position for years, to the terror of the ever-present "botch." A large part of the city being then on piles, the running of mains under the conditions of a swift-running, rising and falling tide tried the patience, skill and swimming ability of the men so employed, as few there were that did not receive an involuntary bath.

About 1864, contentions became manifest from rival corporations asserting themselves. King Street, Potrero, Butchertown and the Pacific Gas Improvement Company followed, as named, in rapid succession, which resulted in absorption or consolidation and consequent over-capitalization, with the exception of the last-named company, who pooled their issues into mutual understandings. Man-

ifestations from the electric current presented themselves, the first exhibition being what was then known as the Jablokoff candle at " Cheap John's," on Kearny, near Clay street, San Francisco, in the shape of an arc light. In the meantime Mr. Beggs was succeeded by J. R. Smedberg, from Memphis, Tenn., who erected additional benches of sixes (Clays), introduced self-sealing retort lids of his own designing, installed and perfected the Pelouze and Audouin condenser, and put in operation a chemical annex in the shape of an ammonia works for producing aqua, sulphate and carbonate of ammonia.

The King Street works, also the Potrero works, had become absorbed, and it fell to the lot of Mr. Smedberg to engineer the lowering of a 24-inch live main some 30 feet to the level of the railroad cut at the Potrero—rather an expensive undertaking. Mr. Tyler Sabbaton of Albany, N. Y., succeeded Mr. Smedberg but remained but a short time, death ending his usefulness. Mr. James Beggs, brother to William, succeeded Sabbaton and J. B. Crockett succeeded Beggs.

Electricity had begun to demonstrate itself as a factor in the competition for public recognition. High candle power burners and regenerative lamps were sought for and introduced. The Lungren, Siemens, the Jenney and Albo Carbon—the merits of each were investigated. Prepayment meters, made in England, were brought out and tried. A water-gas plant was installed at the Potrero and regenerative firing was adopted in retort benches.

Material reductions in price of gas had been made at different times to meet exigencies, which will be a part of the compiler's task to resurrect and present at some time in the future. The Welsbach burner made its appearance and was welcomed in its yet undeveloped form and composition as a champion to maintain the standing of gas in the field of illumination.

The appearance of E. C. Jones of Boston on this Coast was a happy event, not only to the company that employed him but to the gas fraternity, both far and near, that came within the circle of his genial influence. The construction of the North Beach station from his plans and under his supervision speaks more eloquently than words of his ability in his chosen profession, for from his fertile brain emanated a works that was the admiration of the craft as to order, cleanliness, completeness of construction and efficiency in operation—a source of satisfying pride and profit to both officers and shareholders alike. The president, Mr. Crockett, found in Mr. Jones a consistent adviser and an efficient engineer. With these two busy brains came the inception and invitation that formed this Association, Mr. Crockett being its first President.

The consolidation of the San Francisco Gas Light Company with the Edison Light and Power Company is comparatively recent.

This covers in a rather desultory manner some of the changes. The spasmodic efforts to introduce the Tesse Du Montay, the Gale & Rand, as well as the Hall processes, have not been touched upon. The paralleling of street mains, the over-capitalization of stock, the summing up of the vast bulk of good gold expended in the various efforts to furnish light and divide business during the past fifty years in the metropolis of the Pacific, must be left to those better skilled in the art of transcribing history, for but a bare skimming can be presented in the limits of a paper already too long. Still, I can not drop this subject without paying respect to the old and faithful heads of the several departments, who were with the company in the early sixties—John Barr on construction, Dan Quigley on street mains, Owen Gaffney on services, Jake Radstone on meters, Mike Hartnett and John Kelly over stokers, John Cunningham as brick mason, and " beautiful " Barney Keenen—all, with one exception, passed to the silent majority while in the harness of this company. I believe there are two still in the company's employ. I refer to Edward T. Floyd and John Yablonsky.

1854.

SACRAMENTO, named by the Spanish-Mexican Catholics in honor of a Christian institution, comes next on the list as a patron of coal gas. The Sacramento Gas Company was incorporated August, 1854, by James Murray, Angus Frienson, N. W. Crittendon, Walter M. Rockwell and Edward Taylor. Price of gas, $9.00 per thousand. Adinoram Pierce, David E. Knight and Charles Simpkins were in the service of this company prior to their Marysville enterprise. Sacramento, although dignified with the title of " The City of the Plains," did not forge ahead, and for a number of years three benches of threes were found ample to supply all demands. Mr. Pierce, J. R. Watson and William Bryan were successively superintendents; 1862 found John Q. Brown in charge with Harry Adams and Bill Davis assisting.

The old works were situated just north of the old Sacramento River bridge and were selling gas at $6.00 per thousand. The most notable event concerning this plant was raising the street mains to conform to the new grade, some fifteen or twenty feet above old Sacramento. Most of the city was so raised to avoid inundation, the river having filled with mining debris or tailings. This task required money, pluck and executive ability to keep the town supplied during the hours of illumination.

The City Gas Company was incorporated in 1871, but information regarding this company is vague, a flash in the pan, more than likely. A strong effort was made by some Philadelphia capitalists to enter the field with a concern known as the Citizens' Gas Light and Heat Company, which was incorporated in 1872. They built on the grounds now occupied by the present works, selling gas at $2.00 per thousand, the old company reducing their price to $4.00 per thousand.

The Capital Gas Company, incorporated in 1875 by Albert Gallatin, R. I. Clark, C. H. Cummings, J. R. Watson, James McClatchy, J. W. Pew, Oliver Eldridge, William Alford and D. W. Tallant, absorbed the Sacramento

Gas Company and the Citizens' Gas Light and Heat Company. Mr. Brown retired as superintendent and accepted the position of State gas inspector. Mr. J. C. Pierson appears on the scene as superintendent. This city then became the "Mecca" for electric light advances. The Brush, the Thomson-Houston and the Central Electric Company coming each in their turn for purchase, the money departing often accomplishing their end. As Ben O. Steinman, their president, has said, "They had all kinds of light—gas lights, electric lights and Israel lights." It was a city of Poles.

In 1894 this company had a disastrous fire, ruining their electrical annex, but by indomitable energy, and kindly assisted by confreres in the business, Mr. Pierson, by some makeshifts, was enabled soon to maintain current. The Folsom Light and Power Company about this time were under headway to enter this same field, which they eventually did, and, I understand, narrowly escaped bankruptcy, but by inducing the North Yuba Electric Company to extend their power lines to Sacramento, they were thereby saved. George W. Jackson succeeded Mr. Pierson, who retired to attend to his mining interests.

The Sacramento Natural Gas Company, incorporated December, 1896, by J. Hass, J. McCarmiels, Henry Keyes, T. Quayle and J. N. Jensen, all of Stockton, commenced distributing gas January 1, 1898, and selling the gas at $1.00 per thousand cubic feet. It is still a factor as a bidder for public patronage. The old company has had all but "a bed of roses" to recuperate on.

Water-gas apparatus was installed by the United Gas Improvement Company, which was afterward superseded by the new Lowe Crude Oil, and is now run under the supervision of R. P. Valentine in the interest of the California Gas and Electric Corporation.

1857.

MARYSVILLE, named in honor of Mary Murphy, one of the few survivors of the ill-fated Donner Lake party, comes third on the list. In 1857 various propositions were made to the common council relative to lighting the city. Charles H. Simpkins, a prominent citizen of Marysville and who had the ability to perform whatever he undertook, together with A. F. Williams, who has been well and favorably known as connected with the water ditches in the northern part of California, made proposals on similar terms to those made with William Glen in January, 1855, for furnishing the city with gas and pure water. Messrs. Tiffany and Wethered, two well-known citizens of San Francisco, had also made a proposition to the council, as also Dr. Teegarden of Marysville and D. E. Knight, a gentleman connected with the gas works in Sacramento, contemplated making a similar proposition.

On the 22d of May, 1858, the Marysville Coal Gas Company was incorporated by David Edgar Knight, Charles H. Simpkins and Adoniran Pierce, capitalized for $50,000, which was increased to $100,000 on May 29, 1875. The incorporators organized by electing D. E. Knight president and William Harvey secretary, on May 10, 1858.

The right to lay pipes through the streets of Marysville for the purpose of distributing gas was granted to D. E. Knight & Co., in exchange for which D. E. Knight & Co. agreed to furnish free gas for lighting all public buildings so long as no franchise was granted to other parties. Knight & Co. then organized the above Coal Gas Company. Under the personal supervision of Messrs. Knight and Simpkins, the latter being interested with the Sacramento Gas Company at that time, the construction work was pushed on to completion by Pierce, and on the 18th day of August, 1858, the first gas was manufactured in Marysville and sold at $12.50 per thousand. The works consisted of two benches of threes, iron "H" settings, erected in a small brick flat-roofed warehouse, capacity 18,000 feet in twenty-four hours. The roof was found quite convenient to stand on while punching out obstructed standpipes down through holes in the roof; a three-inch castiron return pipe condenser in the coal shed; two casks, one above the other, did duty as washer and scrubber; wooden box purifiers using hydrate of lime on perforated sheetiron trays; a three-inch station meter, and workshop presided over by Ike Trump; all situated in a long wooden shed; a 20,000-cubic-foot holder, built flat on top, the sheets running straight across after the manner of sheets on a tin roof, held down by screws into the wooden framework and braces that were on the inside of the holder; the guidepost frame and tank also were of wood. The works were situated about midway of the block between Second and Third streets and B street and Virgin alley, main entrance and office on the alley.

In 1860, with 14,550 feet of mains and 200 consumers, the average output was 200,000 feet per month. The first reduction in price was made December 16, 1860, in response to a petition from the public. A system of discounts was established, 10 per cent. being allowed on consumption of over 200 and less than 1000 feet per week and 15 per cent. on all over 1000 cubic feet. In 1862 a uniform price was established of $10.50 per thousand, income tax added. Weekly collections were made from the business houses and monthly from dwellings, churches, offices, etc.

In the spring of 1867 the works were reconstructed, complete, where they now stand. Ironwork, holder, etc., shipped out from Philadelphia on the clipper ship "Old Hickory," some time in 1866. She was 356 days on the way and given up as lost by the underwriters. The captain lost his commission, but the ship arrived safe in port.

In 1867 a voluntary reduction was made to $9.00 per thousand. Gas was made entirely from the richest cannels from Scotland, Ireland, New Brunswick and Australia, sacked in gunny bags in San Francisco and freighted by steamer to Marysville. Boghead, Ince Hall, Lesmahoga, Albertine (cannels) and Australian shale were then familiar names of coal. Prices ran all the way from $25 to $50 per ton in San Francisco. Freights were then too high to admit the use of lowgrade coals in the interior towns, as the freights from San Francisco to

Marysville, together with drayage, exceeded rates around Cape Horn. Castor beans, rosin, wool waste and pitch-pine assisted at intervals. Lime was furnished by Billy Gwyne, hauled in rawhide baskets from Cave City and delivered in Marysville at $2.00 per basket, about two baskets to a barrel. Fire brick was shipped from the East, packed in straw in crates, at $125 per thousand; tile packed in the same manner, 15x30, at $5.00 apiece. Price paid to the company for gasfitting was 50 cents per foot, including time, fittings extra; coke sold at 1 cent per pound (unscreened), and tar at $7.50 per barrel, purchaser furnishing the barrel. Up to 1895 there were no public lamps of any kind in Marysville.

This corporation was disincorporated on January 18, 1896. The Marysville Gas and Electric Company, incorporated November 11, 1895, succeeded to the business of the former corporation. The new organization was controlled and conducted by D. E. Knight; Simpkins and Pierce, as well as Bill Harvey, all having passed to the silent beyond. Knight died January 5, 1900. In February, 1900, the works passed into the hands of Mr. John Martin and his associates, and are prospering under the present management.

1859.

STOCKTON, named after Commodore Richard F. Stockton, U. S. N., though better known in years gone by as the City of Windmills, comes next. Its works was generally spoken of among gas men as "Noah's Ark," on account of its general ancient appearance and the relics in evidence in its vicinity. It was formed as a company in 1859 as the Stockton Gas Company, with P. E. O'Connor as superintendent. They received their franchise (presumably a protective one) from the city council, approved by the mayor June 25, 1859, selling gas at $10.00 per thousand. They pursued the even tenor of their way until April, 1869, when Harry Adams (father of the present superintendent) became superintendent, and Joseph G. Eastland president. The price was then reduced to $7.50 per thousand.

They installed their first electric arc plant in 1883, and incandescent four years later, being reincorporated under the name of the Stockton Gas Light and Heat Company in 1890. Mr. Eastland, having a controlling interest, was chosen president, and remained so up to the time of his death in November, 1895, and was succeeded by Captain Oliver Eldridge; he again by F. A. Hihn.

Natural gas became a competitor in the nineties, and to offset it the Loomis system was introduced, but the obstacle of changing the entire consumers' burners of the town, or even sections of the town, from illuminating to fuel gas burners, presented itself as being too great. So the set was converted to make carburetted water gas, and was so used up to the consolidation with the Stockton Natural Gas Company, January 18, 1895, which now forms the present Stockton Gas and Electric Company, gas selling now at $1.50 per thousand. Thirteen dollars and seventy-five cents was the first charge for arch; they are now $10.00 less.

1860.

SAN JOSE, the Garden City, next falls in line. The first gas company to incorporate here was the San Jose Gas Company. Its articles were filed on February 25, 1879. The incorporators were James Hagan of San Jose and J. K. Prior and Thomas Anderson of San Francisco; the officers were James Hagan, president; Austin Roberts, secretary.

Although this is the first record of the actual incorporation of the San Jose Gas Company, it had existed probably as a copartnership for a long time prior to its incorporation. The archives of the city clerk's office show that on July 13, 1860, an exclusive privilege was granted to James Hagan to lay mains, build works and furnish gas to the people of San Jose for the term of fifteen years at a rate not to exceed $10.00 per thousand feet of gas. The ordinance granting the privilege contains one section, which I quote for the purpose of showing the cost of coal to be used in gas manufacture, and also to show that even at that early date municipal bodies were aware of and exercised their right to regulate gas rates.

"SECTION 8. That if it shall appear at the expiration of five (5) years from the date hereof that gas can be furnished cheaper than now, having reference to the price of labor and material used in the manufacture of gas (coal now being rated at (53) fifty-three dollars per ton), it shall then be lawful for the city authorities to make such reduction in their discretion as shall seem just, so that the rates shall not be less remunerative than they would be now; and at the end of ten years a like reduction may be made, should labor and material still further reduce."

It is interesting to note in this connection that the railroad communication between San Francisco and San Jose was not established until 1865, prior to which date coal was brought to Alviso in vessels or barges and thence hauled by teams to San Jose, a distance of some nine miles over roads which were none too good at any season of the year, but which during wet winters became impassable through the overflow of the various streams which enter the bay at or near Alviso. During such periods of overflow the coal needed for the gas works was carried from Alviso on pack mules; every once in a while one of these mules with his burden would be swept away while fording some swollen stream and both mule and coal be lost beyond recovery. This being so, there is doubtless quite a deposit of coal and mules somewhere in the Alviso flats.

It may be interesting to note that the first "holder" built and used by this gas company had a capacity of about 8000 feet. The material used in the construction of its tank was three-inch redwood. In the year 1888 this tank was torn out, after having been in use and in the ground twenty-eight years, when its redwood material was found to be as perfect as the day it was built. Part

of this same material was made use of in the buildings at the present gas works of the company.

While the San Jose Gas Company was the pioneer in the work of actually supplying gas to San Jose, there were several efforts made by other parties at various times to procure and exercise this privilege; one of these even antedated the francsise granted to James Hagan and his associates. On January 18, 1858, the city council passed and approved an ordinance authorizing George Wheeler and John Ashley to lay pipes for the purpose of lighting the stores and streets of San Jose. This project apparently came to naught. In 1868 a petition was presented and filed by George Hearst et al., asking for the privilege of laying mains and supplying gas to this city. It will thus be seen that one of our great editors, an aspiring leading candidate for President of the United States, has come by his faculty for distributing "hot air" honestly. On June 20, 1877, another rival of the San Jose Gas Company appeared in the field in the form of the Garden City Gas Company, which was incorporated on that date with Z. P. Boyer of Pennsylvania, J. W. Walker and John H. Brucken of Oakland, J. C. Uhler of San Francisco and W. P. Dougherty, C. B. Hensley and Return Roberts of San Jose as its incorporators. Z. P. Boyer was manager. The works were located on San Augustine street, the present site of the gas works of the United Gas and Electric Company. I believe this company was the first on the Coast to manufacture gas by the Lowe process. After two or three years of active rivalry, the San Jose Gas Company absorbed this corporation and in 1889 was consolidated with the Brush Electric Light Company and reincorporated under the name of the San Jose Light and Power Company.

During the earlier years of the San Jose Gas Company the high rate charged for gas (viz., $10.00 per thousand feet) caused considerable public discontent. The older residents of the city recall vividly their struggle for a reduction in gas rates. John Stock, pioneer hardware merchant of San Jose, in speaking of the matter the other day and illustrating the economy practiced during that period, said, with a twinkle in his eye, "My gas bills were less when I had to pay $10.00 per thousand than they are now with gas at $1.50."

In 1865 a special committee of the city council made an investigation into the business and profits of the San Jose Gas Company and its report showed that the original investment of the Gas Company in 1860 was $21,000.00; that during the first five years of its existence its total expenditures for betterments, materials and labor in the business of gas manufacture was $55,637.93; that their receipts from gas rates during that period amounted to $75,617.00, and that the three founders of the company had divided in dividends $19,979.52, or almost the amount of their original investment.

1862.

GRASS VALLEY.—Gas was first introduced in Grass Valley by Edward McLaughlin, formerly in the hardware business in that city, but now a banker of San Jose. A company was incorporated in 1862 with a capital of $20,000, under the title of "The Grass Valley Gas Company," officers and directors as follows: Ed. McLaughlin, president; A. V. Brady, secretary, and Charles Jenkins as one of the directors.

Gas was made from pitch wood and coal, the price being $10.00 per thousand cubic feet. Holder capacity, 3000 cubic feet. The above company sold out in 1865 to A. Pierce, a resident of Nevada City and also owner of the Nevada gas works and part owner of the Marysville and Oroville gas plants, for $20,000, after which the price of gas was reduced to $8.00 per thousand cubic feet. Later it was transferred to A. A. Mulloy and wife, consideration not given, and shortly after to Peter Johnston and A. B. Dibble about 1871, the two latter paying $16,000 for the plant.

Pitch coal and wood were still used, and price of gas being $8.00 per thousand cubic foot. The plant was then enlarged and improved and a 5000-foot holder erected.

In 1882 Peter Johnston sold out to A. B. Dibble for $8000, and price of gas was reduced to $6.00 per thousand cubic feet.

In 1685 A. B. Dibble sold out to John Glasson, price not stated. Gas sold at $5.00 per thousand cubic feet, and was still made from pitch wood and coal.

In 1898 John Glasson sold out to the Nevada County Electric Power Company, consideration not given. Gas was then made from crude oil and reduced to $3.00 for illuminating and $2.50 for fuel. Even at these prices very little gas was sold, less than sixty consumers using the same in Grass Valley, very little fuel being sold.

In 1901 the Nevada County Electric Power Company was absorbed by the California Central Gas and Electric Company and the plant has been run from that date up to the present under the name of the Nevada County Gas and Electric Company.

In 1902 a new high-pressure plant was installed by the Lowe Crude Oil Water Gas Company and a two-inch main was run to Nevada City, a distance of 4½ miles, one plant thereby supplying both towns. The storage capacity has been increased at different periods and the price of gas has been reduced to $2.00 per thousand cubic feet for illuminating and $1.50 for fuel, which are the present prices. Number of consumers has increased fourfold, owing to extension of mains and fuel gas being used for cooking, etc., together with the new price of gas.

A brilliant future is insured for gas both in Grass Valley and Nevada City, with the excellent plant this company has now installed.

1863.

PETALUMA (a Spanish word meaning "Duck-Hill") entered the list of gas cities on September 14, 1863, when the Petaluma Gas Light Company was incorporated with the following directors: William W. Beggs, Captain Charles M. Baxter and W. B. Minturn. The materials for construction, with the exception of the holder, mains

and tank, were taken from the junk pile and refuse heap of the San Francisco Gas Works. There were two benches of ones, cast-iron, and a 7000-cubic-foot holder in a wooden tank that was sunk half its height into the ground and the earth taken out and piled up around the other half. John Cameron of Philadelphia supervised the work, under the direction of Mr. Beggs. Tom Beggs (no relation to Billy) laid the mains. He could polish off a joint in less time and in better shape than any man I ever knew. James Eckles and the writer fitted up the buildings of the town, and John Barr and Matt Douty constructed the works with John Cunningham as bricklayer.

About Thanksgiving Day of that year gas was first turned into the mains and the town lighted at $10.00 per thousand. Peter Donohue shortly after secured a controlling interest, and installed his son, Mervyn J. Donohoe, as superintendent. During his administration the holder tank burst, the holder collapsed and desolation reigned. The wreck, or what was left of the plant, was purchased by E. T. Farmer, L. A. Kelly and their associates, who reconstructed a plant at the lower or opposite side of the town, Mr. Kelly acting as superintendent. (The original mains of three-inch and four-inch, in nine-foot lengths, Scotch pipe, are at this writing in the ground, doing good service.) Gas was reduced to $8.00 per thousand.

Later on, the plant passed into the control of the banker, I. G. Wickersham, who enlarged the plant by extending the mains, reducing the selling price to $5.00 per thousand. About 1897, Mr. F. W. Van Sickle induced Mr. Wickersham to change from coal to what was known as the Van Sickle system, using crude Coalinga oil to alternately generate heat and produce gas, using air as a diluent. This remained in operation for five years.

In the latter part of 1900 Mr. Wickersham disposed of his interest to the Petaluma Gas and Electric Company, making consolidation of the gas and electric system for the first time in Petaluma. Rates were then reduced to $2.00 per thousand for heating, $3.00 for illuminating.

In 1901 the California Central Gas and Electric Company purchased the stock of the said company, and introduced their pipe line, pumping gas from Santa Rosa through eighteen miles of two-inch pipe under pressure from the Lowe generators at that town.

Both Beggs (William and Tom), Barr, Doughty, Cunningham, Cameron, Baxter, Eckles, both Donohues, and Wickersham, have all passed over the Grand Divide.

1866.

OAKLAND, named for the numerous oaks in its locality. The Oakland Gas Lighting Company was incorporated June 12, 1866, by Joseph G. Eastland, Andrew Chabot and William W. Beggs, all since deceased. Henry Adams, from the Sacramento Gas Works, was the first superintendent of the company, remaining with them from the starting of the works in April, 1867, until July, 1868, when he was succeeded by Van Leer Eastland as superintendent, who remained with the company in that capacity until his death, September 8, 1894. Andrew Chabot was the first president.

The first installation consisted of one bench of three iron retorts, one single purifier 6x8 and a holder having a capacity of 10,000 cubic feet. This holder was further supplemented by one completed in 1868 having 20,000 cubic feet capacity. All the mains laid at that time were cast-iron and the outlet pipe of the works was three-inch. In 1873 an 80,000-cubic-foot holder was completed, outlet to works eight-inch, and the retort house increased to three benches of fives, all of these benches being of the open setting type. Two additional purifiers, each 8x8, were installed.

In 1877 the distributing part of the works was removed from First and Washington streets to the block bounded by First and Second, Jefferson and Grove, when a double lift holder, having a capacity of 450,000 cubic feet, was installed, and a purifying house containing four purifiers 12x12x4, all of modern type, were also installed.

In 1879 a Lowe water gas set was installed, having a capacity of 20,000 cubic feet per hour. The retort house in the meantime was extended so as to comprise altogether twelve benches of fives, although at no time were more than eight benches ever used. When the works at First and Jefferson were installed, the outlet of works was changed from eight-inch to sixteen-inch, as it now remains.

In 1877 franchises were obtained and a holder erected in the town of Berkeley and the town of Alameda, the one in Berkeley having a capacity of 50,000 cubic feet and the one in Alameda 20,000 cubic feet. Subsequently, in 1883, in the city of Alameda, a double-lift holder, erected by Deily & Fowler of Philadelphia, was installed, having a capacity of 150,000 cubic feet, which holder is still in service. The Berkeley holder has been dismantled. Both towns are really being supplied by the high-pressure mains from the Oakland station. In 1886 a three-lift holder, capacity 750,000 cubic feet, was built.

In 1885 the Springer set was installed in Oakland, having a capacity of 30,000 cubic feet per hour, and in 1887 an additional one with similar capacity. In 1899 a Western gas set was installed at the Oakland station with a capacity of 50,000 cubic feet per hour, and in 1902 a Lowe crude oil water gas set was installed, having a capacity of 100,000 cubic feet per hour. From five miles of main existing in 1868, the amount has been increased in the entire territory to over 200 miles. So much for the physical end.

As to the personal end, as mentioned before, the three incorporators have died, as have also the two superintendents. The following named presidents of the company have all since passed to the great beyond: H. H. Haight, ex-Governor of the State of California, was president from 1867 up to the time of his death. Joseph

G. Eastland, was secretary of the company from its incorporation until 1883, and president from 1883 to the time of his death in 1895. The other presidents who served for a short time were: Anthony Chabot; W. W. Crane, Jr., ex-mayor of the City of Oakland; Hon. J. West Martin, ex-mayor of the City of Oakland; John W. Coleman, president of the North Pacific Coast Railroad Company, now known as the North Shore, and D. E. Martin.

Of the men who assisted in the construction of the work and the general laying down of the plan, aside from Van Leer Eastland, who was directly in charge of it all, I recall W. W. Beggs and James Beggs, his brother, James R. Smedberg and Homer Bloomfield, all of whom, with the exception of Smedberg, are now dead. John Barr was for many years foreman of pipe work, and it is interesting to note that his son, Dan Barr, is now a collector for the company. John A. Britton is now the only living representative of the Oakland Company of the old regime. He commenced work with them in the spring of 1874, as meter setter, meter repairer and general laborer, was elected secretary in 1883 and president in 1899. In connection with the gas business, the company took on the electric light end of it in 1882, in the month of January, and has since controlled the entire field in that district.

Voluntary reductions in gas rates in the City of Oakland were made as follows:

1867, rate $7.50 per M.
1870, rate 6.75 per M.
1871, rate 6.00 per M.
1872, rate 5.00 per M.
1874, rate 4.50 per M.
1875, rate 4.25 per M.
1876, rate 4.00 per M.
1877, rate 3.75 per M.
1879, rate 3.50 per M.
1881, rate 3.25 per M.
1883, rate 3.00 per M.
1886, rate 2.75 per M; $2.50 per M for gas stoves.
1889, rate 2.50 per M; 2.25 per M for gas stoves.
1894, rate 2.25 per M; 2.00 per M for gas stoves.
1895, rate 2.00 per M; 1.75 per M for gas stoves.
1897, rate 1.75 per M; 1.60 per M for gas stoves.
1898, rate 1.50 per M; 1.25 per M for gas stoves.
1900, gas for municipal purposes, $1.00 per M.
1903, rate $1.25 per M; $1.00 per M for gas stoves.

1866.

VALLEJO was named for General M. G. Vallejo, owner of an immense Mexican land grant of 250,000 acres in that section. Mare Island was his reserve to pasture his mares.

In 1866, a Mr. Young, formerly connected with the San Francisco Gas Company, constructed a gas works in Vallejo. The apparatus was open to the weather, no buildings, sheds or cover other than the sky. A 7000-cubic-foot holder floating in a redwood tank that leaked so badly that the fireman had to perform the act of waterman when the tide was out, by pumping water into the tank from the river with a four-inch Spear pump.

The town was first lighted with gas July 4, 1866; the price was $7.50 per thousand. Mr. Young was unfortunate enough one day to discover that a party named Lee, a hotel keeper, was by-passing gas regardless of the meter. In endeavoring to correct matters, Lee shot him, Young dying from the effects of the wound in something over a month.

General Frisbie became interested, and soon after erected the present works in another part of the town, three benches of threes, and a 20,000-foot holder. Mr. Peter B. Fagen became superintendent and W. J. Tobin secretary. In 1876 Mr. J. R. Smedberg was called on to lay a two-inch pipe across the Mare Island, as the small Maxim affair erected by J. K. Prior on the island did not render efficient service. Mr. Smedberg connected his pipe together on Georgia street, reinforcing the screwed couplings with cast-iron sleeves, leaded and caulked. A cable was made fast to the pipe and connected with a capstan on the island, and it was pulled across the river, a couple of empty barrels being made fast to the forward end of the pipe to buoy it up over any possible obstruction or plowing down into the mud. An Otto gas engine supplied the motive power to force the gas across and blow out probable water seepage or condensable matter that otherwise might accumulate in the pipe.

The gas was received in a small holder on the island to give a uniform pressure and to prevent oscillation from the pumps on the Vallejo side. General Frisbie retiring from the gas business, Mr. Wilson of Vallejo became controller. Mr. Fagen obeying the inevitable call that awaits us all, Mr. J. W. Thomas appeared upon the scene as superintendent.

The next notable change at this works was the converting of a single-lift gas holder into a double or telescope while doing duty, thereby doubling its capacity. This engineering feat was engineered through by E. C. Jones, the Bay City Iron Works being the contractors, and completed in 1896, an account of which is given in the Proceedings of the P. C. G. A. of that year, is well worth the reading, as I believe it was the first attempt to cup the bottom sheet of an old holder while it was in use.

A notable incident connected with the history of this company is that Hetty Green, said to be the richest woman in America, is a stockholder, which is another evidence of this lady's good judgment in making her investments.

1867.

NAPA, an Indian name, after a tribe known as Napas.

The gas business at Napa dates from 1867. William Smith and E. E. Chalmers secured a franchise and they conveyed their rights to James H. Goodman, James Freeborn and William W. Beggs, who incorporated "The

Napa City Gas Light Company," with a capital stock of $80,000, on May 25, 1867. Mr. Beggs was at that time chief engineer of the San Francisco Gas Light Company. The plant was built at a cost of $16,000. The works were located on a lot 60x120, between Main and Brown streets, fronting on Fifth. The building, of brick, was a counterpart as to size and style of the then Oakland Gas Works, which was also designed by Mr. Beggs. The office, condensing and purifying room, retort house and workshop were all under one roof. A 7000-cubic-foot holder floating in a redwood tank, two benches of iron retort, one retort in each bench (one bench being in reserve), capable of carbonizing 200 pounds at a charge. Oak wood and whatever coke was made was used to keep up the heats, carbonizing Scotch and Australian cannels costing from $20 to $30 per ton, schooner's freight, $2.50 per ton, and drayage, $1.00, added. As all coal sold in San Francisco for reshipment had to be sacked, 25 cents per hundred for gunny bags and 5 cents a sack for filling and sewing made this carbonizing material rather gilt-edged by the time the cost of dumping it into the coal shed was added. From 4 to 4½ feet to the pound was the estimated yield, as no station meter was on the premises. The condenser, a three-inch upright return pipe affair, made of tin, as also was the center seal, both furnished by Morris Dobzinsky (the first manufacturer of gas meters on this Coast). Two redwood boxes for purifiers, 4x5x3 feet, with wooden screens for dry lime, lime costing $2.25 per barrel. All pipe around the works beyond the condenser were of galvanized sheet-iron, soldered at joints, made and put up by local tinsmiths.

Gas was first turned on and the town lighted September 1, 1867. Harry Adams, formerly with the Sacramento Gas Company, and later as superintendent of the Oakland Gas Works, was the first superintendent at this place, gas selling at $7.50 per thousand to sixty-five consumers, the county paying for thirty-three street lanterns. Nine dollars each per month was the modest charge, they being lighted and extinguished according to moonlight schedule, the post and lanterns belonging to the company. All renewals and repairs were paid for by the county. The street mains were mostly of condemned boiler tubes 2½ inches in diameter, in six-foot lengths, joined together with cast-iron sleeves, leaded and caulked.

In April, 1869, Mr. Adams resigned, having accepted the position of superintendent at the Stockton Gas Works. The writer succeeded Mr. Adams. At this time James H. Goodman, James Freeborn and Captain Harry Parker were directors; Richard Dudding, secretary. About this time the lull caused by civil strife was fast disappearing and the evidence of prosperity began to assert itself over the whole State, and Napa fell in line. The income tax was abolished; the growth of the town became manifest by extensions and renewals, and the price of gas was reduced to $6.00 per thousand. Benches of twos, large Clay, were introduced and they were capable of working off from 300 to 400 pounds of coal each at a charge; purifying room remodeled, the old flues being substituted with cast-iron, and mains of larger size; lamp posts increased in number and decreased in price to $6.00 per month each. New conditions having arisen, soft coals had come into use, Nanaimo from Vancouver; Greta, Wallsend and other Australian coals commonly known as Sydney coals, enriched either with Anvil Creek cannel or shale from Australia, or Peruvian cannel. Coke sold at $20 per ton, tar at the rate of 10 cents per gallon. Dividends began to appear at the rate of 15 per cent. on actual investment. This warranted the company to again voluntarily reduce the price of gas to $5.00 per thousand, and ninety street lamps to $4.50 each per month.

On August 13, 1888, the directors concluded to erect a new works, and Mr. John Fullagar, formerly superintendent of the Cincinnati, Ohio, Gas Works, was authorized to proceed for the company, also to disincorporate and reincorporate under the name of "The Napa Gas Light and Heating Co.," articles of incorporation dated November 20, 1888. Its first board of directors were George E. Goodman, Theo. R. Parker, E. S. Churchill, Isabella Parker and James Freeborn; H. P. Goodman, secretary, and John Fullagar, superintendent. The new works were efected on the present site, a 20,000-cubic-foot holder, a six-inch works complete with a Hicks setting of Clays. Price of gas was again reduced, to $4.00 per thousand, street lamps to $3.50 for all night and every night service. In 1889 Mr. Fullagar resigned to take charge as superintendent of the San Jose Gas Works. New settings were installed from plans suggested by the Kneischers of New York, designed by A. C. Woods of Syracuse, N. Y., which were eminently successful as gas producers of the full regenerative type, five retorts, capable of carbonizing one ton of coal in four hours, giving a yield on an average of 11,000 feet. Time having wrought changes by age and death, Goodman, Freeborn, Beggs, Adams, Dudding and Captain Harry, having performed their part on our little globe, were to us no more, and those remaining desiring peace and retirement, accepted an offer from Dr. Thomas Addison and John L. Howard, August 1, 1899.

In the spring of 1901 the California Central Gas and Electric Company became the owners, inaugurating a complete change, discarding coal and installing the Lowe oil generators, and have greatly increased the output.

1871.

SAN RAFAEL was named for one of the numerous saints in the calendar.

The first gas plant in San Rafael was started by Mr. Allen Lee in November, 1871. It consisted of a Maxim machine and gas was sold at $5.00 per thousand.

In 1876 Mr. Lee formed a partnership with Mr. J. O. Eldridge and they built the first holder and coal gas plant and continued to operate until December 5, 1887, when the company was incorporated.

The incorporators were Charles E. Green, Sidney B. Cushing, Allen Lee, E. G. Stetson and Upton M. Gordon. In 1883 the price of gas was reduced to $4.50 per thousand, in 1885 to $3.50 per thousand, and in 1890 to $3.00 per thousand.

Mr. Lee was president and manager until his death in 1894. Mr. Cushing succeeded him to that office, and held it until August 14, 1901, when the plant was purchased by the California Central Gas and Electric Company. Mr. J. S. Kaneen was secretary and superintendent from 1890 to 1901.

1872.

SANTA ROSA.

A concern known as The Maxim Gas Company was the first to present a gasoline vapor and sell it as gas to the citizens of this place. This company was incorporated April 15, 1872. F. H. Coe, John Brown, C. Kessing (afterward State Inspector of Gas Meters), E. T. Farmer and W. B. Stanley incorporators. On account of its irregular candle power it became unsatisfactory, and was abandoned. The Santa Rosa Gas Light Company was formed and incorporated March 18, 1876. The directors were John E. Ayer, L. A. Kelly, C. F. Juillard, E. T. Farmer and W. G. Atkins, L. A. Kelly acting as superintendent for this and the Petaluma plant. Australian and Vancouver coals were the chief carbonizing materials used, costing from $14 to $16 per ton. Gas selling at $7.50 per thousand. Two benches of threes, a six inch pipe condenser, wooden box purifiers, using dry line. The works were erected on the premises of the present works. (They having been but recently torn down by M. G. Osborn, our past president, to make room for new installations.) Messrs. Kelly, Kessing and Ayer disposed of their interest to John A. Paxton and John S. Kaneen. Mr. Kaneen acting as superintendent. It is interesting to note that for an entire year late in the 'seventies, under his supervision gas was made exclusively from wood of the red fir, costing at the works $10 per cord. He estimates that from it he obtained from 14,000 to 18,000 cubic feet to the cord. For a long time the refuse from vineyards such as grapevine sticks, leaves and litter, the seeds and pomace from the wine presses. These were spread out in the sun to dry, it being the main difficulty in using this material to eliminate the moisture it contained. As an enricher Mr. Kaneen used Peruvian oil, costing $2.25 per barrel; he used iron pots measuring 12 inches by 14 inches by 8 inches, filled two-thirds full with this oil, leveling off the top of the pot with sawdust. One of these pots was placed in with each charge, which assisted the yield, bringing it up to twenty candle power. The gas from this composition was disposed of at $4 per thousand up to 1886, when the price was reduced to $3 per thousand. John Barr, familiarly spoken of as Johnny Barr, formerly with the San Francisco, Petaluma and Oakland works, appears as superintendent. (Mr. Kaneen, I believe, had been called to Los Angeles by Charles Simpkins, the promoter of that works, to superintend.) In 1887 Mr. Berry succeeded Barr as superintendent. On May 10, 1888, Mr. Paxton died; his death precipitated a change in affairs, as Mr. Kaneen, acting for the Paxton estate and also for himself, sold the entire stock to Messrs. W. B. Cline, president of the Los Angeles Lighting Co., C. O. G. Miller, president of the Pacific Gas Improvement Co. of San Francisco, and J. M. Livingston, president of the Pacific Lighting Co., for $55,000. The name of the company was changed to the Santa Rosa Lighting Co. Capitalized for $100,000. Mr. Livingston president, Mr. Miller secretary and treasurer, Mr. Murdock superintendent, he being succeeded by Mr. A. Gutsch in February, 1896. The plant now consisted of two sets of fives, open setting, and considered a full six-inch works. Mr. F. H. Eichbaum, chief engineer of the P. G. I. Co., was called in consultation for betterments. Three benches of fives, half regenerative furnaces, a steam jet exhauster, a condenser and scrubber and four cast-iron box purifier and a 35,000-foot holder was the result. In 1897 the works were sold to Philip Meyer (of Welsbach fame) "on a promise to pay." He kept the works three years, but he could not keep his promise. He failed for $56,000 and no assets. Mr. Gutsch was returned as superintendent. In August, 1901, the California Central Gas and Electric Company acquired the properties, both gas and electric being held in common. They have installed the Lowe Crude Oil Gas Apparatus. Strictly speaking, the Santa Rosa and Petaluma gas field should be considered as a single unit, as the latter is utterly dependent on the Santa Rosa pipeline for its supply of gas.

CHICO, meaning *small* town or village—used a limited supply of artificial gas some two years prior to the organization of the Chico Gas Company, *i. e.*, in 1872, the distribution being effected through wooden pipes in a very limited section of the city. Gasoline gas was made at first in benches consisting of three round iron retorts, each four inches in diameter and seven feet long, and this gas, which had an average illuminating value of eighteen candle power, was sold at $6 per thousand. Afterward, the gasoline plant was abandoned and oil gas was made and delivered direct to the holder at a water pressure of five inches, but it is recorded of this oil plant that it made more lampblack and oil tar than gas. But to revert to the earlier period of the company's existence: It was organized December 8, 1874, and incorporated as the Chico Gas Company on December 19th of the same year, its first officers being Messrs. A. Bullard, president and treasurer; George F. Nourse, vice-president; C. L. Stilson, secretary, and N. P. Fuller, superintendent. These gentlemen, together with Messrs, J. W. Giltyson, John E. Ayer and L. A. Kelly constituted the first board of directors. Originally there were but three stockholders, in addition to the names already mentioned; they were George W. Dorn, E. Rose and H. C. Copeland. Various changes occurred in the personnel of the company throughout the years which in-

tervened, before its absorption by the Chico Gas and Electric Company, at which time its principal officers were Messrs. F. C. Lusk, president, and A. G. Simpson, secretary. As may have been inferred, the making of gas from crude oil at that time in Chico was no more of a success than it had been elsewhere, and accordingly it was abandoned some ten years ago and a coal-gas plant installed (where we find Gilbert H. Taylor presiding as superintendent). This was in turn displaced by a Lowe water-gas plant in 1898, and that again by the present Lowe crude oil system, introduced on account of its advantages of economy and cheapness of oil, the set now used having a capacity of 3000 feet per hour of twenty-four candle power, and is presided over by A. J. Stephens as manager, in the interest of the California Central Gas and Electric Company.

1876.

WOODLAND, another Oakland.

The gas business in Woodland began in 1869, when the Pacific Pneumatic Gas Company was established, of which Ira P. Rankin was president and W. B. Isaacs was secretary. There is no record at hand showing the amount of business done by the company. In 1876 this plant was deeded to the Woodland Gas Company, of which J. O. Maxwell was president and J. Q. Brown Jr. was secretary.

In 1886 the Woodland Electric Light and Power Company was established, and shortly after J. Q. Brown Sr. sold his interest in the gas plant. Later, in 1888, the Woodland Gas Company sold to the new company, known as the Consolidated Electric Light and Gas Company, of John Martin was president, J. Reith manager, and A. W. Gable of Woodland were directors.

In January, 1891, the Woodland Gas and Electric Company, the present owners of the plant, was formed, and in April of the same year the property of the Consolidated Company was transferred to this new company, of which John Martin was president and J. Reith manager, and Thomas Thompson superintendent.

Reviewing the history of the plant, one is impressed by the fact that while in the early days of gas industry the amount of gas sold was greater during the winter months, to-day the greater amount is sold in the summer and early fall months, showing conclusively how fuel-gas has grown to be the leading factor in the business.

1883.

FRESNO, Ash (a tree).

The Fresno Gas and Electric Light Company was incorporated in 1883, with Louis Leach, president; F. G. Berry, vice-president; W. W. Phillips, secretary; Alex. Badlam, S. N. Smith, directors; S. N. Smith, superintendent. Price of gas, $5 per thousand. Coal gas was used. Price of gas was reduced in 1884 to $4 per thousand, and in 1890, the price per thousand was reduced another $1. At this time a Lowe water-gas set was installed in duplicate. In 1896 the price of gas was reduced to $2 per thousand in order to compete with a water-power transmission plant, which threatened to take all the lighting business, for there was no fuel trade to speak of.

The company did not pay very well for the next year or two, but through a lot of hard work in introducing gas stoves it finally came out with flying colors.

Mr. D. Decker was in charge from 1890 to 1897, when Mr. A. Gutsch took charge until 1898. Up to this time it took all the profits to get the fuel business introduced. At that time there were 750 consumers out of a population of 12,000.

The directors and officers at this date were Louis Einstein, president; F. G. Berry, vice-president; L. P. Drexler, Leopold Gundelfinger, C. W. Barrett, Paul Huntzsch, secretary; George S. Colquhoun, superintendent.

The business steadily increased as the city grew, until up to 1902 there were 1100 meters in use, out of a population of about 15,000.

Mr. John Martin purchased the controlling interest of the company for the California Gas and Electric Corporation.

Under the direction of Mr. E. C. Jones, about ten miles of high pressure mains were laid, also an improved Lowe crude-oil water gas set was installed.

The high-pressure system, in addition to supplying consumers is used to bolster up the low-pressure system, giving a uniform pressure, even at the out-lying ends of the low-pressure mains.

The price of gas was left at $2 per thousand, but a discount of 25 per cent. is allowed when the bills are paid at the office on or before the tenth of each month, making it $1.50 per thousand. There are now about 1750 consumers, with about 1300 ranges in use.

1886.

COLUSA, a rancheria name. The exact Indian pronunciation is exceedingly difficult to give, so the name passed through different modes of spelling until finally fixed by the legislation as Colusa. It has no known meaning.

The Colusa Gas Company was incorporated March 5, 1886, and the directors were George Hager, D. H. Arnold, W. P. Harrington, A. Bond, J. W. Goad, W. D. Dean, E. W. Jones. J. W. Goad was the first president of the company, and M. G. Elmore the first secretary. Price of gas $4.50 per thousand.

In April, 1886, Mr. C. B. Ballentine was elected secretary of the Colusa Gas Company to succeed Mr. Elmore.

The first month 78,000 cubic feet of gas was sold. The first year 1,110,000 cubic feet. The subscribed capital was $25,000. M. J. Boggs was elected secretary December 1, 1890, to fill the vacancy caused by the death of Mr. Ballantine.

October 23, 1901, the Colusa Gas Company changed its principal place of business to No. 31 New Montgomery street, San Francisco. At that time it became a part of the California Central Gas and Electric Company, who bought out the pole line erected by Dr. Coke, under the name of the Colusa Light and Power Co.

P. M. Downing became the manager of the new company, now known as the Colusa Gas and Electric Company, and electricity was first brought into Colusa in October, 1901, from the Butte County Power Company's power-house at Centerville.

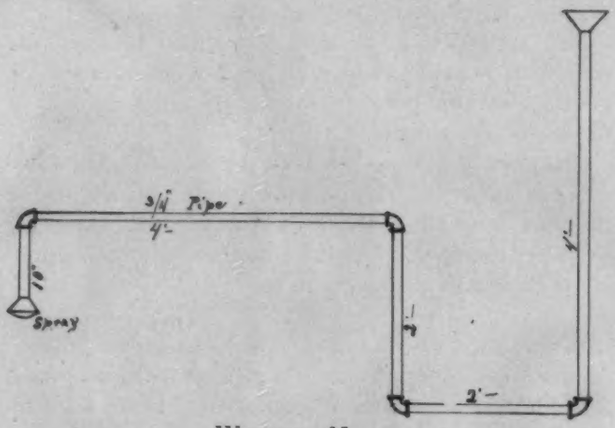
The Lowe crude-oil system was put into operation at the gas works at the same time. The rate for fuel gas was $2.50 per thousand, illuminating $3.50 per thousand, with a discount of 50 cents per thousand if paid before the 10th of the succeeding month.

John D. Kuster became manager of the Colusa Gas and Electric Company in November, 1902. May 1, 1903, the price of gas was made for fuel $2 per thousand, and $3 for illuminating, with a discount of 50 cents per thousand as formerly.

WRINKLES.

BY GEO. S. COLQUHOUN.

I WANT to take the opportunity of thanking the members who have so kindly helped me to gather the Wrinkles for this our twelfth annual meeting, and hope that the members will remember the Wrinkle Department as generously next year.



WRINKLE NO. 1.

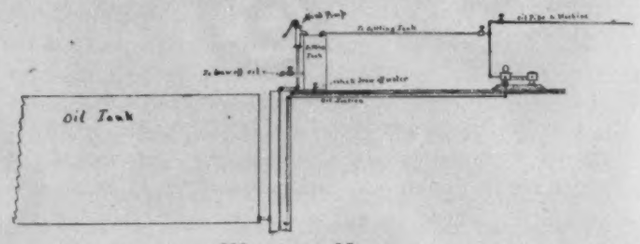
A Device for Clearing Naphthaline at Outlet of Holder. By John D. Kuster, Colusa, Cal.

This device was used when we had naphthaline trouble at the outlet to the holder. When the holder is full, insert the pipe under the edge and into the pipe if it is at any reasonable distance from the edge. The dimensions given on the illustration attached we found necessary for our purpose. With a funnel you can pour in gasoline or kerosene, which seems to cut any ordinary deposit.

WRINKLE NO. 2.

Device for Saving Time and Labor in Dictating Letters. By Mr. Vanderlynn Stow.

In dictating letters I use a numbering machine, the letter bearing the number put upon it by the numbering machine is handed to the stenographer and she takes it with her notes. Letter No. 1 in each day's correspondence stands for itself and the machine is set so that the next letter is numbered No. 2. Thus, the letter which I am answering from you would be, say, No. 1. Formerly my method was to say to the stenographer, "Answer letter from the Pacific Coast Gas Association, dated March 24, 1904, address No. 1030 First street, San Francisco, Cal., attention Mr. C. E. Smith." Now, by using the numbering machine, I say to the stenographer, "Answer No. 1." The stenographer understands that No. 1 means all that I took time to say before and fills that all in without taking up my time to dictate it, or her own time to take it down. Elaborating on this again, if there is a particular paragraph to which I wish to call attention to in the letter, that paragraph can be numbered and the attention of the writer drawn to it without my taking up the time necessary to quote it to the stenographer.



WRINKLE NO. 3.

Settling Tank and Connections.

We have found the apparatus sketched very useful in disposing of the greater quantity of water which finds its way into our oil. We have tried to show how we can pump the water from two points. The oil pump is used if there is an accumulation, otherwise the use of the hand pump once or twice a day is sufficient. We draw the water off in the trough until the oil appears, then allow the oil to flow back into the suction tank, or draw it off at the point shown half-way up the settling tank.

WRINKLE NO. 4.

Exhaust Pipe and Muffler Paints.

The following paints have been recommended as being able to withstand anything up to a red heat, and are therefore suitable for painting exhaust pipes and mufflers:

Lampblack, 3 pounds; graphite, 3 pounds; black oxide of manganese, 1 pound; Japan gold size, 1 pint; turpentine, ½ pint, and boiled linseed oil, 1 pint.

Powder the graphite and mix all the ingredients to a uniform consistency. Give two coats.

Or, black oxide of manganese, 2 pounds; graphite, 3 pounds, and terra alba, 9 pounds. Mix and pass through fine sieve, then mix to required consistency with the following compound: Sodium silicate, 10 parts; glucose, 1 part, and water, 4 parts.

WRINKLE NO. 5.

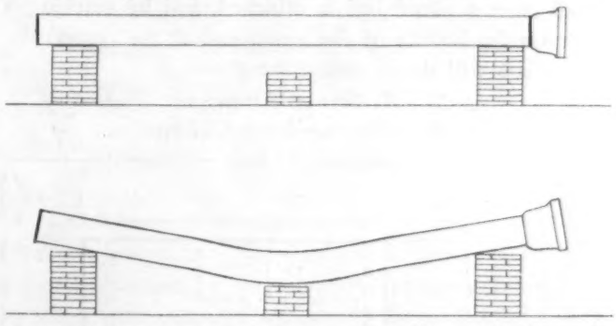
When a large gas-consuming territory has grown in area without the provision of feeding mains for equally distributing gas throughout the territory, it becomes a serious problem to supply increasing demands for gas and give good service. For example: If, owing to a large amount of friction, due to small mains, the maximum

presure of a three-lift gas holder is necessary to provide satisfactory service, the difficulty is increased, because at the time of greatest demand for gas it is extremely difficult to have the heaviest holder in the city on the third lift. It is more apt to be on the first lift, and oftentimes the demand for gas is supplied by other lighter holders contributing their share at a lower pressure. This combination of circumstances occurred in Oakland last winter and the difficulty in handling it was increased by the rapid growth of the business due to a reduction in the price of gas. The main gas supply of the city was fed from a three-lift holder giving pressure as follows: Third lift, 7 inches; second lift, 5½ inches; first lift, 4½ inches; and a two-lift holder giving 4½ inches on the second lift and 4 inches on the first lift. It became necessary to mechanically increase the initial pressure on the city to a point equal to the pressure of the third lift of the heavier holder, and in casting about for a means of doing it, every type of positive mechanical exhauster was examined and found not to be suited to the requirements, as it is an unusual practice to place an exhauster directly in the only feeding main of a large city, as there are so many small happenings, such as the slipping of a belt, the stoppage of power, etc., that might cause the exhauster to stop and the cessation for a moment would shut the gas off from the city, as the exhauster at rest acts as a closed valve. After a careful examination of the Sturtevant gas fan, it was decided to place a 20-inch fan directly in the line of pipe leading from the outlets of the holders and to use an electric motor to run the fan. The inlet of this gas fan was connected to the outlet of each gas holder and the fan was further provided with a by-pass. The fan installed has a capacity of 460,000 cubic feet of gas per hour, and a range of initial pressure up to 19 inches. In laying out the arrangement of fan and by-pass, it was calculated that should the fan stop owing to any accident, that the distance between the ends of the blades and the inside of the case of the fan was sufficient to give an area fully equal to the size of the holder outlet, so that there would be no obstruction to the free passage of gas through the fan while it was not in motion. This proved the greatest source of satisfaction and confidence, and the only other question which arose which might interfere with perfect results was the regulation of initial pressure of the fan to the exact requirements of the district. This it was at first intended to accomplish by means of throttling the by-pass valve, which would require the constant attention of a man and possibly some annoying variations in pressure, when it was suggested by Mr. A. C. Beck, the superintendent of the plant, that the gas fan be placed immediately at the inlet of a 24-inch Connelly governor and that the governor would take care of the proper reduction of the pressure from the fan. This, so far as we know, was After the installation of the fan at the inlet of the Conwithout precedent, and was tried with some hesitancy. nelly governor, and with the by-pass valve open, the electric motor was started and the fan turned over at the rate of about 1900 revolutions per minute. The by-pass valve was gradually closed, thereby putting the fan directly on the city, and the Connelly governor, without any special preparation or change in its mechanism, took hold of the pressure and reduced it to the normal holder pressure. After this, all that was required was to provide a number of lead weights for weighting the governor and increasing the pressure to any point desired. The high rate of speed of the gas fan precludes any pulsation of the gas in the street mains, and it was at first thought desirable to run the fan at its maximum rating and to leave the by-pass valve partly open. This was done simply to so increase the number of pulsations as to insure steadiness of the pressure, but with the by-pass valve open it was found that the governor did not do its work readily, and there was considerable unsteadiness of the pressure. It was then decided to reduce the speed of the fan to about 1050 revolutions per minute, which gave a pressure of 11½ inches on the inlet of the governor, to run with the by-pass tightly closed, and to depend entirely upon the governor for regulating the pressure. This fan was put into operation shortly before Christmas, 1903, and has been working satisfactorily since, and the required pressure is maintained upon the city mains, no matter what the height or pressure of the storage holders, and the gas service has been so much improved that the winter was passed without complaints of insufficient or varying pressures.—E. C. JONES.

WRINKLE NO. 6.

Bending Cast-Iron Pipe.—By T. R. Parker, Napa, Cal.

I send you this rough sketch of an old wrinkle, not in general use, for few there are that think of bending cast iron. My first attempt was at a lumber camp in Calaveras County. Our cook could not bake bread in the stove oven on account of the cross-piece between the lids having become bent or warped so that it allowed too much cold air to pass over his oven. He asked me if I could



straighten it. I thought the same medium that bent it could unbend it, so by putting it in the forge and getting it to a bright cherry red, then placing it on the anvil upside down, and with a gentle pressure from the sledge-hammer, brought it down straight again. So when occasion required to swing around a curve with nothing but straight lengths of cast-iron pipe to do it with, I have done this, building a fire around two or more pipes, as the case might be, and letting them warp down until the center pier wall touches, then knock out your fire, using no water to extinguish it. I have made some very pretty

bends this way for the water company, withstanding 150 pounds pressure. You pile the wood after the manner that a blacksmith heats his tires.

WRINKLE No. 7.

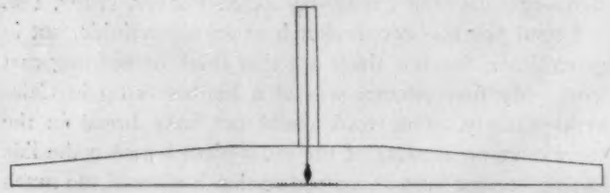
New Use for Gas Engines.

This is, I think, a new idea for use of gas. It is a high-pressure water system for fire protection, in use in Philadelphia. This system is composed of large mains with suitable hydrants located in the business center of Philadelphia, connected with a pumping station on the Delaware River, where large pumps are driven with gas engines connected with the city gas mains. The water pressure carried is 300 pounds per square inch. A single stream from this system threw water almost to the top of a twenty-one-story building, near where a test was being made. The economy and efficiency of the gas engine for the purpose has been fully demonstrated by Philadelphia, she being the first city to adopt gas engines for her pumping station. Other cities have used a similar high-pressure water system, but not run with gas engines. This Wrinkle was taken from an article in the June number of the *Popular Mechanics.*

WRINKLE No. 8.

Grading Board for Grading Pipe Trenches or Leveling Ground.

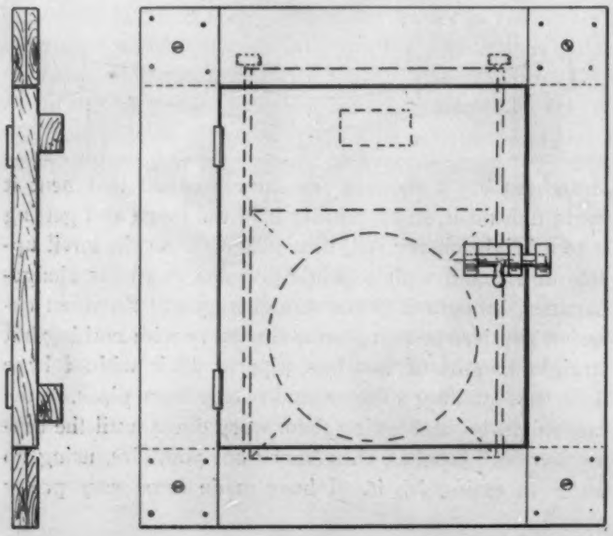
This device can be made from an ordinary piece of lumber six or eight inches wide and the desired length, with a piece about three feet long, attached at right angles and



in the center of the grading board. From the top of the small piece a plumb-bob is attached, and by marking a scale on the bottom of the board and at the center, the plumb-bob will then indicate the grade.

WRINKLE No 9.

A Meter Door.—By S. C. Lowe.



These doors are constructed of redwood, and after you cut a hole through the rustic under the porch, instead of saving the pieces of lumber to make up a door, I take and screw on one of these doors to the casing. This makes a very neat and quick covering, doing away with all carpenter work. The outer frame of the doors are constructed of about 1x4-inch surfaced redwood and halved together. The door is then fastened with an ordinary hinge to the frame and a bolt put on so that when the man goes to set the meter at a house where it can be gotten at from the outside, he always takes one of these doors with him, so that after he finishes the setting of the meter, a coat of white paint or any other color that the building may be painted with, applied to the door, will make a neat looking job.

WRINKLE No. 10.

A Time-Saver in Repairing or Checkering Gas Apparatus.

When a water-gas or oil-gas set needs lining or a renewal of the checker brick, it has been customary to cool the brickwork by blowing air from the blast pipe through the machine, and as the generator and superheater contain a considerable amount of lampblack or carbon in other forms, the air has a blowpipe effect, burning the carbon and increasing instead of diminishing the heat, and at best the method employed is slow.

Last winter it became necessary to quickly repair a large-sized oil-gas set in order to increase its gas-making capacity, and the machine was needed to supply the city with gas. It was found that not more than thirty-six hours could be devoted to the cooling of the heavy linings and the checker brick, and the removal and replacing of a large quantity of checker brick. It was imperative that the repairs should go on, even though some damage might be done to the linings by cooling them too quickly, and this was done by admitting a large quantity of steam at the bottom of the generator, passing it over through the superheater and out through the stack valve. The steam was turned full on at the beginning and permitted to flow through the machine until the temperature of the lining had been reduced to the temperature of the steam.

The steam, upon entering the generator, immediately quenched any ignited carbon, and the cooling effect began at once without any previous reheating. This experiment was tried with some little fear as to its effect, but it was found that no harm had been done to any of the brickwork, and at the end of twelve hours men were enabled to remove checker brick from the superheater twelve feet in diameter. Under methods previously employed, it would have required some days to cool the linings.

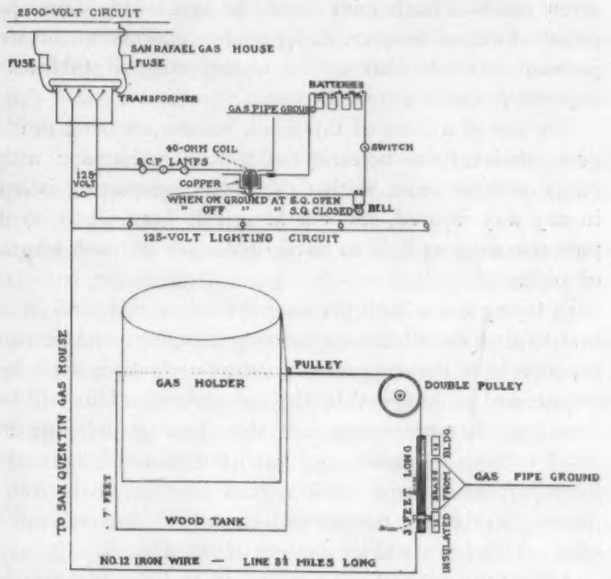
Relying upon the success of this first experiment, this rapid means of cooling oil-gas apparatus is now generally employed, with no bad results and with a great saving of time.—E. C. JONES.

WRINKLE No. 11.

Signal Line Between Gas Works at San Rafael and Holder at San Quentin, a Distance of Three and One-Half Miles.

Arranged so that lamps in series at gas works burn while holder is between one-half full and one foot from

top. As soon as holder drops to half full the lamps go out and relay magnet opens, closing battery circuit on



bell, which will continue to ring until switch is opened. The pump is started and as soon as holder is within one foot of top, bell will ring again. In this way holder is kept between one-half full and full.

WRINKLE NO. 12.

Steam Jet Exhauster.—By Wm. Henderson, Redlands, Cal.

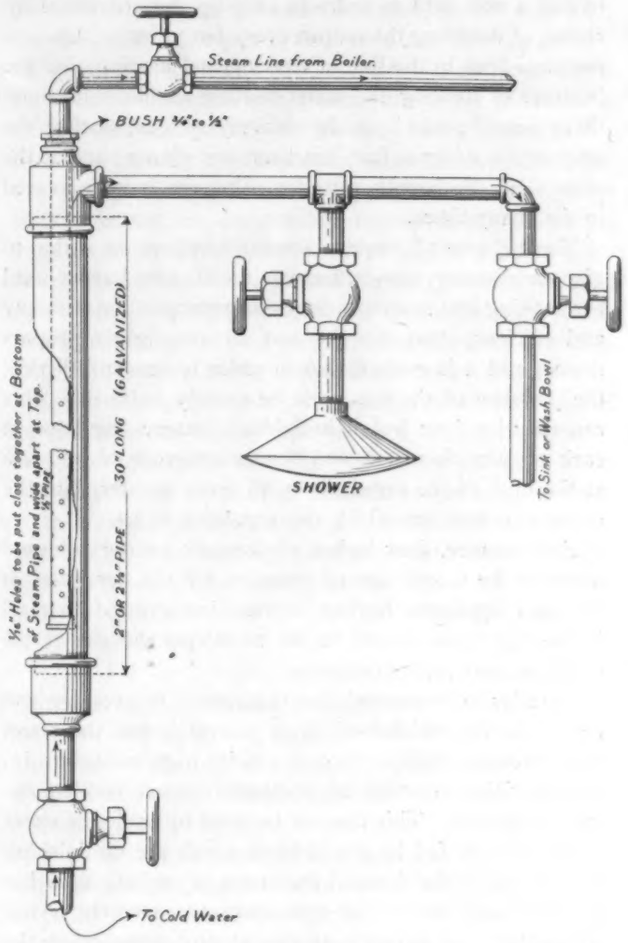
When we installed the second holder it became necessary to use the old one as a relief holder. The holder gives a pressure of 48-10, while the relief holder without any weight had 20-10. The exhauster (of the regular steam jet style) is placed between the relief holder and a scrubber which condenses the steam and takes out any tar that may have passed through the washer and scrubber. The gas then passes through the purifiers and into the distributing holder.

Another benefit was noticed; when we had but one holder it was weighted to give 48-10 pressure, our machine would make 5500 feet of 20 c. p. gas per hour, taking between eleven and twelve gallons of oil per thousand. After taking the weight from the holder and turning it into a relief holder we can make from 7500 to 9000 cubic feet per hour, and make 20 c. p. gas with 9.5 oil per thousand.

WRINKLE NO. 13.

Device for Warming Water for Shower Bath or Wash-Basin.

This device is made with a piece of 2-inch or 2½-inch pipe, 2 feet 6 inches long. At the lower end it is reduced to ¾ of an inch. Where the cold water enters at the upper end there is a reducing T to ¾ of an inch. The side opening is where the hot water is taken off to shower or basin. At the top of T there is inserted a perforated tube of ½-inch pipe with cap on lower end. This tube is connected with live steam line. You can get the desired temperature of water by adjusting the valves on the cold water and steam inlets. This will be found very handy,



and a cheap shower for use at the works, or any place where steam is to be had.

PRESSURE POINTS.

BY E. C. JONES.

WHEN the Pacific Coast Gas Association was formed, it took for its emblem a circle of pipe and this suggested the motto, " No Dead Ends." This was adopted as an ideal condition of gas distribution, but at that time it was thought hardly possible that this condition would be realized in a few years.

The best system of what is known as low pressure distribution with cast-iron mains and large feeding mains reaching out from the storage holders does not and can not meet the requirements of the ordinary gas consumer for satisfactory service. The initial pressure is constantly changing as the storage holders are raised or lowered, and the " peaks " of demand for gas are supplied by " valleys " of pressure. No matter how well arranged the system of piping may be, there is always a difference between the initial and terminal pressures in the district, and as the demand for gas increases, this difference becomes more pronounced.

Owing in a large measure to the successful introduction of incandescent electric lighting, gas has been forced to find a new field in order to keep up the proverbial increase of doubling the output every ten years. This new field has been in the line of cooking and heating, and the business of cooking and water-heating has brought about three new "peaks" in the delivery of gas, during the preparation of breakfast, luncheon and dinner; and at the same time, the burner units for using gas have increased in size many times.

These "peaks" require special handling in order to give satisfactory service, because the Bunsen burner used for cooking and heating must be so arranged for economy and efficiency that the gas and air are rightly proportioned, and it is evident that in order to accomplish this, the pressure of the gas must be exactly uniform. This can only be done by an individual presure regulator at each consumer's meter, and the maintenance of pressure at the inlet of the regulator at all times greater than the outlet pressure for which the regulator is set.

For instance, four inches of pressure (water column) seems to be a satisfactory pressure for the operation of any gas appliance having Bunsen burners, so that all house regulators would be set to deliver the gas at the outlet at four inches pressure.

In order to be assured that this necessary pressure will be constantly maintained, it is essential that the street main pressure shall be kept at a point high enough to insure sufficient storage of pressure against sudden demands for gas. This can not be done by ordinary street main systems, fed by gas holders which are diminishing in pressure as the demand increases, or on long stretches of small pipe where the consumers are severely trying the capacity of delivery of gas at any pressure at the farthest end.

High pressure distribution has come to our relief, but it came into the field like a whirlwind, and the gas men of the country began to consider the distribution of gas at pressures of from 25 to 300 pounds to the square inch. After much experience, this whirlwind of ideas has been harnessed and refined so that now its application is adapted to the existing needs.

For instance—if it is desired to supply a town or a chain of towns at a distance from a central gas-making point, it is first necessary to make a careful estimate of relative initial cost and operating expenses between various sizes of pipe and the initial pressure necessary to deliver the required quantity of gas with ample margin for growth. This leads the engineer into a mass of calculations, with the result that he is astonished at the large amounts of gas which can be forced through long lengths of two-inch pipe at moderate pressures, and the increase of business is provided for by the ability to increase the initial pressure up to the economical limit of single stage compression, say 80 pounds per square inch.

An installation of this character requires good workmanship and material. The pipe should be carefully tested, thoroughly protected against corrosion, and the pipe should be what is known as "plain end," with no screw points. Each joint should be made with some approved form of coupler, using rubber gaskets which are jammed down so that only a feather edge of rubber is exposed to the action of the gas.

The use of a joint of this kind, besides insuring tightness, obviates the necessity of touching the pipe with tongs or other tools, so that the protective coating is not in any way injured, for it is almost as harmful to lay a pipe uncoated as it is to have bare spots on each length of pipe.

In laying out a high pressure system of this kind, it is best to first install the compressor complete, and to run the pipe from the compressor, testing each day's work by compressed air supplied by the compressor. This will be found much more convenient than testing the pipe in small sections by means of a hand pump, and it is sometimes helpful to use a small amount of ether at the compressor, so that the compressed air will have a noticeable odor. This facilitates the finding of small leaks.

After the installation of pipe line and compressors is completed it should be the duty of the gas engineer to determine how low a pressure may be carried, rather than how high a pressure can be carried, and this study will lead to the installation of compression tanks for storage along the line of the pipe, and a gradation of pressures, regulated by district governors to meet the requirements of each separate portion of the district to be supplied. This is for economy, safety and assurance of constant supply of gas.

In California, the towns of Grass Valley and Nevada City are supplied with gas under high pressure. These towns are situated 4½ miles apart and the high-pressure pipe line connected them is two-inch wrought-iron pipe with screw joints. The pipe is well protected and shows no sign of leakage. The gas is made at Grass Valley and is stored in compression tanks at a pressure of 80 pounds per square inch, while the compressor is operated by a gas engine, so that the cost of compression may be easily determined.

The pressure is reduced to 20 pounds by means of a district governor and this presure is maintained throughout the transmission line to a point where the transmission line joins with the distributing system of each town, where it is reduced to 15 pounds. Every meter is provided with a separate pressure regulator, as above described.

Another instance of high-pressure distribution is the town of Petaluma, which is connected with Santa Rosa by a two-inch pipe line 16.8 miles long. The gas is made at Santa Rosa and is compressed and forced to Petaluma at pressures to meet the demands of the consumers, which at present are as follows:

6:30 A. M. to 8:00 A. M.....25 lbs.
8:00 A. M. to 10:00 A. M.....15 lbs.
10:00 A. M. to 11:30 A. M.....40 lbs.

11:30 A. M. to 4:00 P. M.....15 lbs.
4:00 P. M. to 6:00 P. M.....30 lbs.
6:00 P. M. to 6:00 A. M.....10 lbs.

The distributing system of Petaluma is of small-sized steel pipe and the gas is distributed under high pressure in a manner similar to that employed at Grass Valley and Nevada City.

The town of San Mateo is also supplied under high pressure through 2½-inch pipe line, something over eight miles long, from Redwood City.

Aside from the advantages of high-pressure distribution of gas in small cities and between cities, high pressure fills the need of a larger field, and one of growing importance, in "boosting" the pressure in cities where the low-pressure distribution system consists of small mains with numerous dead ends, whereas without the help of high pressure these distributing systems would have to be condemned and replaced by a modern system.

One of the best examples of this system in practice may be found in the city of Fresno, which is piped with small mains, and as the city has rapidly grown these mains have been extended in all directions until it became a problem to maintain any pressure and supply of gas at extreme points. At the same time this city was rapidly growing in two directions in what is known as additions, and these additions were built up with a good class of houses, requiring gas for cooking and heating.

To save the old distributing system and supply gas to these additions, a two-inch loop was laid completely around the city from the gas works back to the gas works again, and at the principal dead ends of the old low-pressure system connections were made with the high-pressure loop, using a district governor to reduce the pressure to four-inch water column.

This arrangement equalizes the pressure at every point in the city, and should an accident happen to any of the district governors by the breaking of a diaphragm or otherwise throwing the high pressure directly into the low-pressure mains, the gas holders at the works act as a safety valve to keep the presure down to a point where no damage can be done to ordinary tin gas meters or fittings designed for low pressure.

This emergency has never arisen, but the safeguard stands ready at all times. From this two-inch loop high-presure wrought-iron mains lead out into the additions and the houses are connected by ½-inch services and governors at the meter, so that the city of Fresno is supplied by a combination system, the same loop reinforcing the low-pressure district and supplying a high-pressure district. The initial pressure on the loop at the gas works is 15 pounds per square inch.

A resume of personal experience with high-pressure installation has demonstrated the importance of the following points:

Always provide duplicate compressors.

Never depend upon a source of power which will fail, unless another means is at hand. This is particularly important where a gas compressor is operated by an electric motor, for should the electric current fail at any time, the gas consumption immediately increases, usually two-fold, for the reason that gas is then used for lighting to take the place of electricity. Unless there is a residual which supplies cheap boiler fuel, gas-engine power is the most reliable and satisfactory for running compressors.

If the capacity of the transmission line will not store gas enough under pressure to supply the consumption for thirty minutes, use compression tanks. In any event, the use of compression tanks is in the line of economy, because the tanks may be located above ground, are easily accessible, perfectly gas tight, and the compressor works at a constant speed and pressure into the tank or tanks, and the pressure at the outlet of the tanks may be governed to any desired point. A reliable check-valve should be placed in the line of pipe between the gas compressor and the compression tanks to prevent the gas from blowing back in the event of an accident to the compressor.

In laying pipe, each length of pipe should be stood on end and all scale and dirt hammered out of it. All pipes should be carefully examined for splits before being painted with two coats of red lead mixed with the best boiled linseed oil.

Should it be thought desirable to make use of screw joints, every joint should be made with line pipe sockets, or other fittings having taper threads to correspond with the taper of the ordinary threads on the end of the pipe. Sockets and other fittings ordinarily used have a straight thread tapped from one end and entirely without taper.

Pipe should be made up one length at a time, and the pipe should be graded to take care of drippage the same as with low-pressure piping, but in the place of drips, outlets with lock stop-cocks are substituted. This is important because the whole or portions of the system may be without pressure in cases of emergency, when water may leak into the pipe from the outside, or the pipe line may become flooded with water during process of construction, and there are many other reasons why it is desirable to give some thought to the proper grading of the pipe, although it is not nearly so vital as in low-pressure gas distribution, because any accumulation of liquid may be easily blown out of the pipe line, and it is never necessary to use a pump.

In calculating the size of pipe necessary, always err on the right side by making the pipes amply large. For instance, a 1½-inch pipe is more than twice as large as a 1-inch pipe, while the price is not twice as much, and the 1½-inch pipe is much stronger and capable of resisting strains from outside.

The special couplers for connecting pipe provide for expansion and contraction, but should line pipe sockets be used in their place it has been found of advantage to lay the pipe in a sinuous line in the trench.

Finally, the advantages to be derived from compressing gas must not be overlooked, and it is a question worthy of discussion whether it is not advisable and economical to

subject all illuminating gas to the physical change which takes place during compression, on account of the condensing and cleansing effect on the gas.

It is well known that the candle power of gas is not affected by raising the pressure to about 20 pounds, on account of the taking out of water up to that point which would otherwise reduce the heating value of the gas, and at pressures over 20 pounds any loss in candle power which, at the most, is almost negligible, is due to the removal of unstable hydro-carbons which would better be removed at the works.

The effects produced in compressing gas by de-hydrating it and condensing out particles of dust, lampblack, or unstable hydro-carbon vapors, greatly improve the service on high-pressure distributing systems, where stoppages by water, naphthalene or dust are unknown. In fact, the advantages of compressed gas are so apparent that all consumers appreciate them and draw comparisons between old and new methods, and it has been the experience at Fresno that low-pressure consumers have asked to be placed on high-pressure mains.

This brief description of high-pressure gas distribution as it exists in California is hardly worthy to be dignified with the title "paper," but it is hoped that there may be some hints contained in it which will be of use to the members who are workers in this field.

THE LABOR PROBLEM.

BY F. J. SYMMES.

IT is quite natural for us to feel that our own events and experiences are entirely new and different from those which have occurred before, but such is not the case. The Greek and Roman babies were just as wonderful to *their* parents and grandparents as ours are to us to-day, and while we lie awake nights to evolve our "original" ideas we discover later that they were in use hundreds of years before. Even the great labor problem of our present day is only a repetition on another scale of troubles of long ago, for whenever and wherever men have come together there have been differences of greater or less importance.

In the beginning men were savages, everybody "went it alone" and nobody cared a "tinker's dam" for his neighbor. Soon, however, the family relation strengthened, the tribal distinctions developed, and from that time on man's dependence upon his fellow-man has grown in strength and importance.

Associations of men in groups according to their mutual interests have existed throughout all civilization. Kindred relations and interests have *always* brought men together, and now we find them in every variety of association—churches, lodges, societies, brotherhoods, clubs and unions—and even parlors.

Among the earliest of these were the "guilds"—men worshiping and feasting together, helping each other in poverty and distress, and providing pensions for those advanced in years. Plutarch tells of them in the first century, the Greeks had them in the second and third, and they were common in the Middle Ages.

The Peace Guild, for mutual protection, was prominent in the fourteenth, and the social and religious guilds in the fifteenth century. All classes of men were members then, and even royalty took part, for Henry IV and Henry VI were each members of the Guild of Trinity at Coventry.

The "guild merchants" and the "craft guilds" became the strongest in wealth and importance until they reached to the point of great excesses and abuses and the days of the Reformation weakened and destroyed them.

Wichliffe in the fourteenth century complained much of the abuses of the trade guilds. In France they were abolished in 1787 and in Germany they lingered along until low water mark in 1869, when they had nearly disappeared. In Russia they never found a healthy soil for growth. Human nature has but little changed. The trade union of to-day is only the oldtime guild fitted to our modern conditions. Ours, however, is a fair weather bird, which thrives only in the most prosperous times. It springs up then like a weed before the rain, but withers and dies down before the heat of "hard times" and when the generous showers of capital fail. It is generally believed—for their leaders have vigorously preached it—that the labor union has been the cause of great improvements in the laborers' conditions, but how much their aggressive acts have stood in the way of *greater improvements* will probably never be known. A victory *after a battle* between labor and capital is usually only a truce. The most lasting peace after war is for those who live apart. Those who must live together must settle their differences by some other method if the settlement is to be a permanent one. And the best results always come from a conclusion arrived at by calm reasoning and a willingness to see and consider the other side. There have been many good reasons for the desire of labor to better itself, as the greed for gain and the opportunity for unjust men to hide behind the irresponsibility of the great corporation has too often tempted them to disregard the just rights of the laborer. On the other hand, the employers who have sought to better these conditions of their own accord are a constantly increasing number.

We have often been told that the workman can do more work in eight hours than in ten hours, if he is contented and in good humor, but how much more can be had out of capital when in good humor is seldom thought of, and it is a very serious question if the labor union has practically accomplished as much real gain for the cause as might have been secured by other methods.

Whether good or bad, however, the labor union is with us, is here to stay—in a more or less active form according to the hard or prosperous times—and is a force to be counted with. It threatens in its most vicious form the health and prosperity of the nation, and if not a dangerous disease upon the body politic, it is a pretty severe afflic-

tion for a real blood purifier. As we have it now, the economic conditions are seriously disturbed and no man may know with any certainty from day to day whether he can count upon his daily bread, his meat or his beer—or even a vehicle to convey him to his grave.

It is the problem of our time, not only from an economical and sociological point of view, but from the political standpoint as well, and by the aid of the selfish and unscrupulous representatives of the press the arraignment of class against class and the distruction of all natural friendliness between the employer and employee has been most unfortunate and will require many years to overcome.

The labor union of to-day is controlled by some of the shrewdest—if not the wisest and best educated—of our time, and for completeness and effectiveness of organization it is probably second only to the Roman Catholic church. It plays most effectively upon the sympathy of the public, the weakness of the politician and the timidity of the employer. It has now hoisted the dignity of the day laborer to a most conspicuous pedestal and tremendously emphasized it, and it has declared the royal trademark of labor to belong alone to such kinds of work as shall form a union and come into its federation. All else is " scab."

The professional organizer has gathered in the carpenters, the painters and the boiler makers, the scavengers, the chicken pickers and the grave diggers, the least intelligent, the least educated and the least American, rounded them up in their flocks and said to them: " We are honest labor, all else are ' scabs.' We *make* everything and should fix the price." And the more socialistic—who are always the foreigners—say: " We make everything and we ought to own everything. We are Labor. Labor is King. Let the King rule. Work only when I tell you, and only as much as I tell you, and I will raise your wages, shorten your hours, and show you how to make capital obey your orders. I will teach you how to perform the minimum of work in the maximum of time at a large fixed wage. You may be without work at times and your family may be hard pushed for food, but they shall not actually starve. Together we will compel capital to admit us to a partnership, where our name shall be in all its windows and upon all its goods. We shall have a share in the profits, a control in the management and no responsibility for the debts. If you do *not* follow my dictation you are a ' scab ' and a villain, you shall not be permitted to work *at all;* women and children will stone you in the streets and strange, bad men will find you when alone and they will break your bones and kick out your brains."

As a result of this kind of persuasion, practically illustrated, the ranks of the unions are kept full, and this is the " organized labor " which demands the " recognition " of the employer. To " recognize " it, we are told, is but a reasonable and simple thing to do. Once this is done, however, we are forbidden to recognize any other kind; the law of supply and demand is set aside and the new King will rule. By a " recognition " of such organizations there has been built up the extraordinary conditions of to-day. A single organization (the United Mine Workers) is said to have 350,000 members and four millions of dollars in their treasuries, and there are others nearly as strong.

This extraordinary force, developing continually in power, in influence—and in impudence—has compelled the formation of the other organizations to combat and restrain it—the citizens' alliances, composed of different classes of people who recognize the necessity of a restraining influence, and the manufacturers' and employers' associations, composed of employers only. This counter movement was bound to come; capital has been compelled to organize for self-protection, and conflict ensues.

We are now in the stage of conflict; skirmishes are common and great battles are always imminent.

Citizens' alliances and employers' associations may not be above criticism, but they have their rightful place and a most important function to perform. They may seem radical and inclined to follow at times the methods of the other side, but they are organized for self-protection, and if compelled to fight they can not afford to *hit soft* or to take any backward step.

As a result of the organization of capital, the organization of labor becomes more tractable and more reasonable in its demands. If the capital organization is reasonable (and from it everything in the way of reason and justice is to be expected,) labor will become better educated and advanced and distinct progress will be made. The same old struggles will be gone over again, but the conflicts should be less and less severe. Time and experience bring wisdom to us all and time and experience are elements of importance in the future solution of this problem. Arbitration and conciliation boards perform an important part in the difficulty, but they are not a cure. They are of much value at critical times when the relations are greatly strained, because they call a truce, consume time and permit passions to subside and reason to develop. But a settlement other than by mutual, willing consent is not a finality, hence the *value* of arbitration is often overrated. A settlement of difficulties which does not settle the feelings is not a permanency, and settlements by arbitration seldom satisfy. First, it is a struggle to secure the vote of the " odd man," and it usually ends in a compromise, a kind of " split the difference " settlement, so that if one only makes his demands large enough at the outset he can always be magnanimous and shout for arbitration. If a man makes a claim for my entire suit an arbitration board will at least give him my hat. One great cause for all this lies in the fact that most of us are *cowards.* The business man fears his neighbor may secure some of his trade if he has a tie-up

of any kind; the politician fears to express himself before a growing political power; many of the courts are still more timid, and the true laborer, the good mechanic, fears for his job and his life if he does not join the union which he despises. The sharp manipulator of the labor forces knows all this and shapes his acts accordingly. The only man who *isn't* a coward is the one who attempts to exercise the American and God-given right to labor when and where he pleases, for he has to take his life in his hands to do it. He is stoned and jeered at as a "scab" by women and children; he finds but little support from the police or the courts, and it is only in rare instances he finds a friend, and then it is usually some citizens' alliance which attempts some little protection. It is a comparatively safe and easy thing to march to battle under the guidance of wise officers and beside many comrades; but to be prepared night and day for the cowardly attacks of a gang of sluggers requires the highest type of heroism. When the public determines to give to the free workman the protection and support which he deserves, the labor problem is solved, and the labor union goes out of the slugging business and settles down to its legitimate duties, the assistance, care and protection of each other *under* the law and—something which never occurs to them now—the advancement and perfection of their trade.

The rights of the "open shop" are as clear as the constitution of a free country and the beneficent intentions of a Divine Father, and they never can be properly questioned. They should not be discussed.

An educated and cultivated people such as ours ought to be able to find a complete solution for the labor question without the sacrifice of our prosperity or plunging us into the distress of hard times. Much has been done and is being done in a more friendly and kindly feeling toward the laborer. Capital has voluntarily shared its profits, improved the conditions about the great factories, assisted to give better and more beautiful homes, and aided the sick and the unfortunate.

This will go on, even though in many places the work has apparently not been appreciated. On the other hand, we must not hesitate to raise the hand of resistance against all unreasonable demands. We must provide and yield to suitable boards of arbitration. All these things are steps toward a better future understanding, and they are all educational and useful. The Bill No. 53,529 of the Fifty-eighth Congress, creating a national arbitration tribunal, should have our hearty support. It may prove a great help. The best progress, however, will be retarded until we repair our immigration fences. We can not make good citizens out of the hordes of ignorant, vicious and depraved of other nations in less than two or three generations, if at all, and immigration restriction is very essential. We can use a large population of newcomers if they are the right kind, but the quality is far more important than the quantity. We need not be in such desperate haste to fill up the country, for we are doing very well as a nation and that well enough should be let alone rather than to increase the disturbing element. We want our America for Americans, and with all the other problems which are before the people in addition to the labor problem, we need a constant upbuilding of character and a sturdy growth in good citizenship. We want to remember that happiness depends upon other things beside dollars and cents, and that this, like any other question, can only be settled aright, when it is settled, by honest, fair-dealing men, upon the lines of equity and justice, with a feeling of charity to all and malice toward none and an exact appreciation of "good will to men." This final solution may seem an ideal and a distant one, but we are making some progress toward it and each must do his part.

NOTES REGARDING CALIFORNIA PETROLEUM.

BY PAUL W. PRUTZMAN.

PETROLEUM has been prospected for in twenty-seven counties in California. Of these, twelve have yielded nothing to the drill, six have yielded oil in small quantities, one seems in a fair way to shortly join the rank of producers, while seven are now producing oil profitably. In these seven producing counties there are fourteen distinct centers of production, or "oil districts," as follows: In Fresno County, the Coalinga field; in Los Angeles County, the City field, Whittier, Puente and Newhall; in Orange County, the Fullerton field; in Santa Barbara County, Summerland and Santa Maria; in Kern County, Kern River, Sunset, Midway and McKittrick; in Santa Clara County, the Sargents district; and in Ventura County, a succession of small pools which are usually classed as one field, with or without other name than that of the county.

Statistics corrected to December 31, 1903, show the following result of operations over the entire State:

Producing wells	2,998
Abandoned wells	1,271
Wells drilling	159
Uncertain	322
Total	4,750

The map (Figure 1) shows roughly the location of the various producing fields, and of the more important of the prospect districts. You will note that all the actual production is from the counties south of San Francisco, though small quantities of oil have been found as far north as Humboldt County. Table 1, which follows this paragraph shows how the production for 1903 was divided over the various counties. Santa Clara County, which now has at least three producing wells, and San Mateo County, where there are a few very small wells, produced but a nominal amount in this year. These figures are due to the courtesy of Mr.Charles G. Yale of the Geological Survey.

TABLE 1—PRODUCTION BY COUNTIES

Fresno	2,200,000
Kern	18,250,000
Los Angeles	1,720,000
Orange	1,450,000
Santa Barbara	220,000
Ventura	770,000
Total	24,610,000

Table 2 shows the production by barrels and in value, of the entire State from 1898 to 1902, and the percentage of the total production of the United States for these years. In 1902 California ranked fourth among the States in the quantity of production, and fifth in the value of the output. The production of petroleum per capita of population in California in 1903 was somewhere about fifteen barrels, while the average for the entire United States was probably very close to one barrel per capita.

TABLE 2—PRODUCTION OF STATE, 1898–1902.

Year.	Barrels.	Value.	Per Cent.
1898	2,249,088	$2,376,420	4.06
1899	2,677,875	2,660,793	4.60
1900	4,329,950	4,152,928	6.76
1901	7,710,315	2,961,122	12.70
1902	14,356,910	4,692,189	16.44

Petroleum is classed as refining oil or fuel oil according to the percentage of lighter and more valuable products carried. Such percentages are not indicated very closely by the gravity, and various conditions influence the limit to which profitable refining can be carried, but as an average it will not be far out of the way to say that, under present local conditions, any oil lighter than 20° Be. is suitable for refining, while any heavier oil is useful only as fuel or for the manufacture of asphalt. Dividing in this manner, the production of refining oil and fuel oil from the various fields in approximately as shown on Table 3, which also indicates the number of producing wells in each district, and the average actual production per well per day. Some remarks are necessary here. Kern River, Sunset, Summerland and Los Angeles City produce only heavy oil, but a portion of this is used in the manufacture of asphalt and has been classed with the refining oil. The small production per day in Sunset, Midway and Summerland is due to the fact that many wells were not being pumped at all, owing to market conditions, though classed as producers. The total production for each district is due to the Geological Survey, but the divisions and the number of wells are my own.

TABLE 3—PRODUCTION OF REFINING AND FUEL OILS BY DISTRICTS, 1903.

District.	Refining Barrels.	Fuel Barrels.	Total Barrels.	No. of Wells.	Barrels Per Well.
Coalinga.....	1,200,000	1,000,000	2,200,000	110	67
Kern River	1,000,000	15,500,000	16,500,000	796	69
Sunset.....	25,000	325,000	350,000	102	12
Midway.....	.....	30,000	30,000	24	4
McKittrick.....	250,000	1,120,000	1,370,000	75	61
Los Angeles....	50,000	750,000	800,000	979	3
Whittier.....	250,000	500,000	750,000	99	25
Puente,.....	120,000		120,000	79	5
Newhall	25,000	25,000	50,000	40	4
Fullerton	450,000	1,000,000	1,450,000	138	35
Summerland ...	20,000	80,000	100,000	198	0.2
Santa Maria....	80,000	40,000	120,000	21	19
Ventura County	70,000	700,000	770,000	306	8
Totals	3,540,000	21,070,000	24,610,000	2,967	27.7

The Refinery.—Petroleum, as you doubtless know, is a mixture of a very large number of substances, many of which have never been separated in pure form. It contains, first and chiefly, several groups or series of hydrocarbons, bodies containing only hydrogen and carbon, each series consisting of a number of compounds of similar properties, but gradually increasing in specific gravity and boiling point as the number of atoms in the molecule increases. These hydrocarbons are gaseous, liquid, and in the higher members solid, but in California petroleum the higher members may all be considered as liquid. The hydrocarbons make up the body of the oil, and are separated by distillation into groups of the same boiling point, or of a certain average specific gravity. It is needless to say that the single or double distillation of the refinery does not separate pure individual hydrocarbons, and that the commercial products are themselves very complicated mixtures. Beside the hydrocarbons there are bodies containing sulphur, others of a basic nature containing nitrogen, others related to the phenols (of which carbolic acid is a type) containing oxygen, and finally asphalt. The asphalt is left behind as the residue of the first distillation, the other impurities are distilled over with the various fractions, and removed by treatment with chemicals and water. The finished products must consist of pure and stable hydrocarbons.

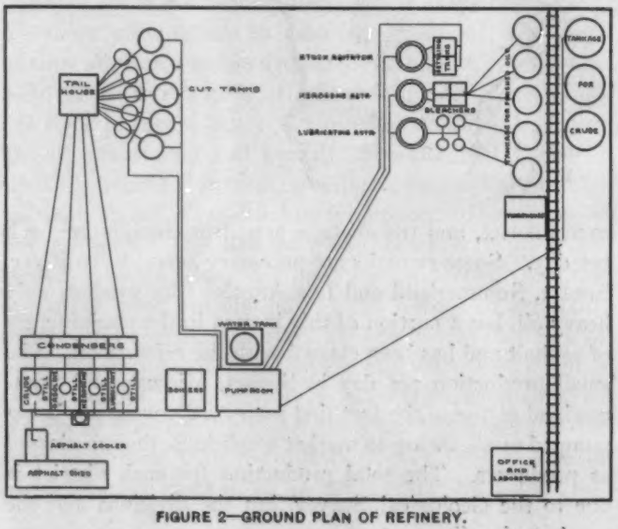


FIGURE 2—GROUND PLAN OF REFINERY.

The refinery, then, consists of apparatus for distilling the crude oil and for redistilling the various products, of agitators for washing the products, of settling tanks and bleachers for removing the last traces of wash water, and of incidental apparatus such as tanks for crude oil and products, boilers, pumps, pipe lines, etc. Figure 3 shows a common arrangement of the parts of a refinery, though of course the grade of crude, products to be made, and individual ideas of builder vary this arrangement considerably.

The still, a sketch of which is shown on Figure 4, is a steel shell, without tubes and generally without bracing.

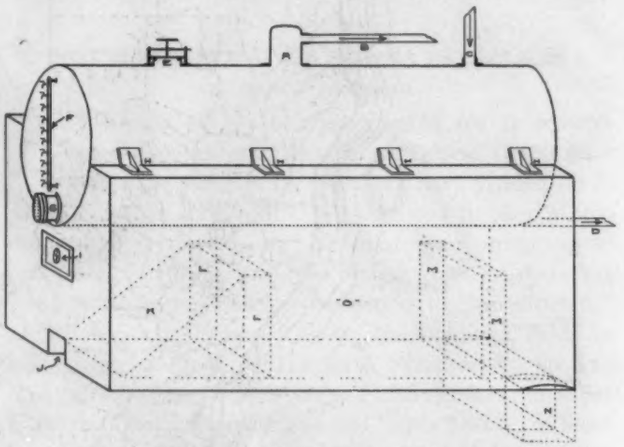


FIGURE 3—PETROLEUM STILL.

It is constructed of steel of low tensile strength, the rivets being spaced rather closer than would be good practice in boiler work, the object being to secure tightness rather than strength. The seams are chipped and caulked outside. Heads are flat or slightly dished, according to the diameter of shell, flat heads of large diameter requiring crowsfoot braces, which are objectionable. Where the size of the shell will permit, bottom is formed of one sheet, to avoid rivet heads coming over fire. The shell is provided with a small dome, at the side of which is outlet for vapors; there are also flanges for steam pipe and fill pipe in top of shell, a flange for draw-off pipe at one end of bottom, and a manhole on top. This manhole is generally circular, of large size, and provided with cast-iron plate fitted on top of ring, and held down by temper bar and screw, there being practically no internal pressure. There is also on one head a manhole collar, with flange and bolt-plate, giving access to shell at bottom, and also a column of length about equal to the diameter of the still, tapped into shell at top and bottom, and provided with pet-cocks for gauging height of liquid in still. A brass and iron expansion pyrometer is usually inserted through the front head, and sometimes a pressure gauge is also connected on.

The setting is commonly as shown in figure, the heads of still coming flush with outer face of brickwork, the

still resting on wall lugs placed at the middle line. Cast lugs are used on large shells, pressed steel lugs where the still is of less than 100 barrels capacity. Lugs rest on roller plates or on slide bars to allow for expansion, which is greater than that of a horizontal boiler. Heads and top of shell are covered in with magnesia, asbestos, or other nonconducting material, to reduce loss of heat and avoid decomposition of the distillate.

The burner is generally inserted through one end of the setting, near the ground, and a draft hole left near bottom line of shell in front wall. A target and bridge wall occupy the fore part of the furnace, a combustion chamber being left between front and rear bridge walls. Back of the rear bridge the fire gases are drawn down into a flue running underground across the end of setting and connected to all the stills where several are set in a battery, one stack thus answering for several stills. It is often thought best to carry a flue out through rear end wall, the cross flue being entirely outside setting, as in this manner a damper may be placed between setting and main flue. The side walls of the setting usually batter a little, though where two stills have a common center wall this wall is more often straight.

From the bottom of the still a pipe equipped with iron gate valve leads to the asphalt cooler. The object of the cooler is to enable the residue of asphalt to be drawn off hot instead of cooling in the still, as at the end of distillation the residue would catch fire if exposed at once to the air, and to allow it to cool in the still wastes time and fuel. The cooler is a cylindrical or rectangular shell of light steel, closed except for a small vent pipe, and supported on brick walls. The cooler is provided with specials valves, similar to the ordinary molasses gate, of large area, through which the partly cooled asphalt is drawn into barrels by means of an open trough.

A pipe from the boiler carries steam to the bottom of the still, where it is allowed to issue into the oil through perforations in a pipe lying along the bottom. The steam assists the distillation, as will be mentioned farther on, and also promotes circulation, which is naturally rather defective. The steam is sometimes superheated in the firebox, more often dried by being carried through a long coil on the bottom of the still itself. The steam must be dry, but should be no hotter than the boiling oil.

From the dome a wrought pipe of large area leads to the condenser. This may be of several forms, according to the needs of the case. The form sketched in Figure 4 is the double-header pattern, in which the cooling pipes are arranged in banks and run into a header at each end, each header except the first and last being common to two banks. The headers are made up of tees and nipples, and a flange union is run into each length of pipe, or better, if space allows, a union may be placed between each pair of tees in the header. This type is difficult and expensive to build, but is extremely satisfactory in use, on account of the very low back pressure. A somewhat similar type has but one header, the condensing pipes being carried down from this in independent flat coils and carried

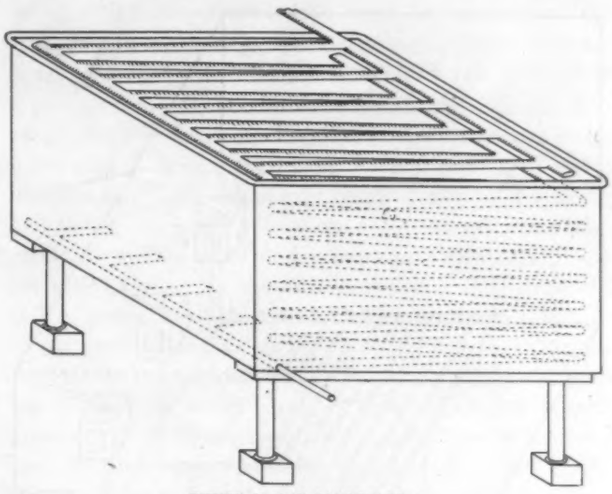


FIGURE 4—THE CONDENSER.

finally into a collector at the bottom. This form is cheaper to build, as fewer unions are required, and is nearly as satisfactory as the first. For a very small still a simple coil built up of wrought pipe may suffice. Whatever the form, the pipes decrease in size downward. The proportions will depend on a number of factors, but some idea may be had from the statement that in a condenser of the double-header type a 6-inch upper header might branch into four or five 3-inch runs; there would be, say, two banks of 3-inch, two of 2½-inch, two of 2-inch, one of 1½, carried into a 2-inch collector.

The coils are immersed in a box of water, the box being of wood in small sizes, of iron in larger. This box is provided with inlet for the cooling water, usually at the bottom, with overflow for hot water, and with drain for cleaning.

The collecting pipe from the condenser is carried, generally for some distance, into the "tail house," or "receiving house." Here the tail pipe is carried into a closed metal box, known as a "sight box," having glass windows in each end, an outlet for oil at the bottom and a petcock for drawing samples. The stream of oil flowing through the sight box may be seen without bringing it in contact with the air. From the sight box the oil flows to a battery of valves on floor of tail house, generally all-iron cocks, by which it is directed into the proper tank. Between the sight box and the condenser a standpipe, open at the top, is carried up for some distance, to take away the gas accompanying the oil. This gas is inflammable and is sometimes collected and burned, but generally allowed to go to waste.

From the tail house the oil flows to the distillate tanks, known as cut tanks. These are steel tanks of low form, covered, into which the oil flows at the top. At the extreme bottom there is a drain for removal of the water accompanying distillate, which settles out slowly, and somewhat higher, the outlet for oil. From the still to the cut

tank the oil must flow by gravity, and the provision of necessary fall is often a difficult matter on flat ground.

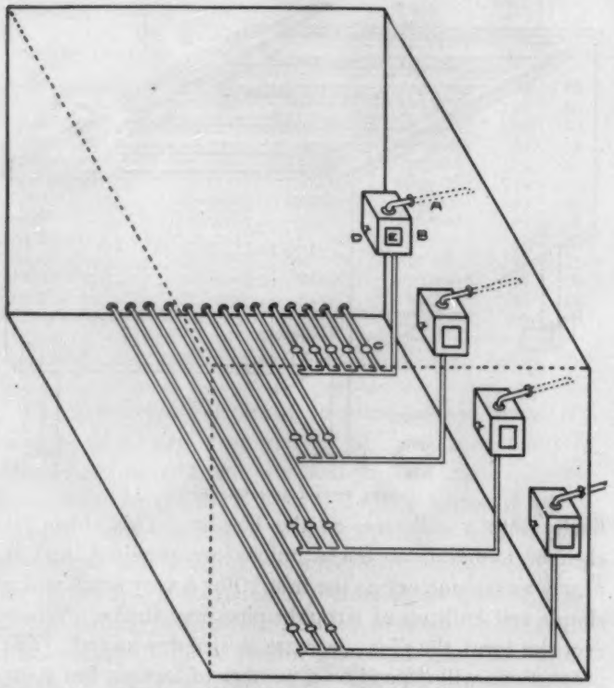


FIGURE 5—TAIL ROOM.

From the cut tanks the distillates are lifted by pump to the agitators. The pumps used for this purpose, like all the oil pumps on the refinery, are usually duplex, low service piston pattern, which combine large capacity with light weight and moderate steam consumption. Fresh and salt water, boiler and fuel feed are taken care of by pumps suited to such uses, and for crude oil compound duplex pumps are often used where size of plant will warrant. Most of the pumps, even on a large refinery, are of small size.

The agitators, sketched in Figure 6, are steel shells of suitable size, open at top and bottom. At the desired distance from the ground an angle supports the bottom of the agitator proper, this bottom being conical and caulked tight to the sides. Through the shell, doors are run at ground level, thus forming a small room under the agitator proper, where the lower valves are manipulated. Saddles attached to the bottom sheets, resting on posts and these in turn on cement blocks, take the weight of the charge, while the empty shell is self-supporting, the lower edge resting on a ring of brickwork. A hood of light sheet metal protects the contents of agitator from sun and rain, while the man in charge, standing on a light iron balcony, can watch the process through openings in the hood. The agitator may or may not be lined with sheet lead, according to preference; iron is attacked but slowly by the concentrated acid used, especially in presence of oil. If lead is used it must be burned in, and is supported by studs let into bullseyes in the side sheets. The agitator is of mild steel, single riveted. A common size is ten feet diameter, twelve feet on the side over bottom angle, eight feet under the angle, four feet deep on the conical bottom, hood about four feet high. In an

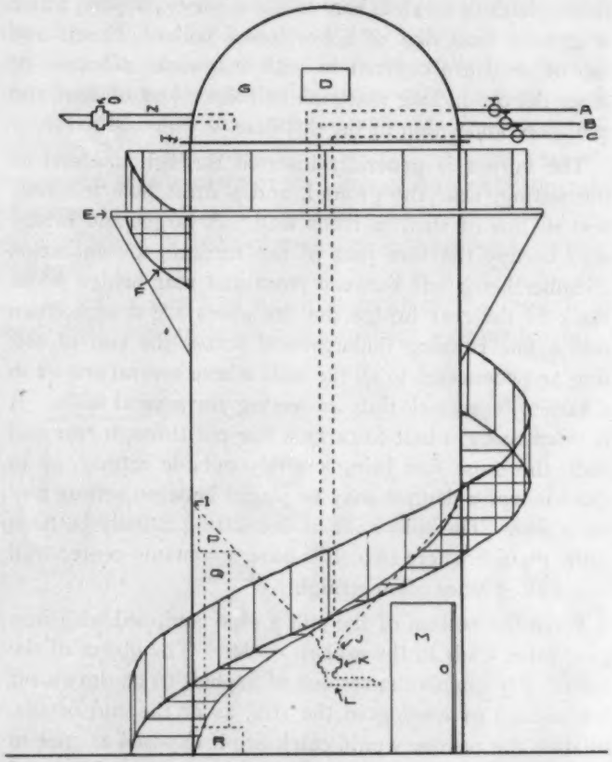


FIGURE 6—THE AGITATOR.

agitator of this size the lower rings and bottom would be of ½-inch, middle ring ⅜-inch, upper ring ¼-inch, hood 3-16-inch.

Agitation is by means of compressed air, which is carried to the bottom on the cone. No more pressure is necessary than enough to balance the weight of the column of oil, but the quantity used is rather large. The spent chemicals are drawn off from the point of the cone into a drain, while a pipe is provided for drawing washed oil into settling or bleaching tanks. Water and steam pipes are connected to the apparatus and chemicals (acid and alkali solution) are lifted by air pressure.

Settling tanks are generally shallow, and often have dished or sloping bottoms. Their object is simply to allow the last traces of water to settle from the oil, and almost any shape of tank will answer. Bleachers are shallow tanks or trays in which kerosene or lubricating oils are exposed to the sun, heated and settled. They are usually raised on platforms so as to be readily accessible. On small plants bleachers and settling tanks are usually of galvanized iron and are often rectangular.

In the manufacture of lubricating oils in the Eastern States, filter presses and gravity filters of bone coal and fullers earth are much used. In this State filter presses are not necessary, as our oils rarely contain enough paraffin to affect the cold test and the manufacture of paraffin scale is unknown here. Boneblack or earth filters are used to

some extent, but in general our lubricating oils are made by rather crude methods.

Distillation.—The distillation of petroleum follows the well-known principles of fractional distillation: First, that when two or more miscible fluids of different boiling point are heated together, the lowest boiling liquid will distill first, but not in a pure condition, carrying over instead a certain proportion of the heavier liquid; second, that as the distillation progresses the proportion of the heavier liquid in the distillate will increase and of the lighter diminish, the boiling point of the mixture gradually rising. In the case of petroleum, as it is a general though not infallible rule that the higher the boiling point of the liquid the greater the specific gravity (and consequently the lower the Beaume number corresponding to the specific gravity), it follows that the (Beaume) gravity of the distillate falls as the boiling point rises.

In the accompanying plat, Figure 7, the curves *A-A* and *B-B* show: *A-A*, the fall in gravity as the distillation progresses, each horizontal line representing one degree Be., each vertical line one per cent. of the crude oil; *B-B*, the rise in temperature at corresponding periods. This oil was 21° crude from Coalinga, and was distilled in fractions of 1 per cent. each, up to 61 per cent.

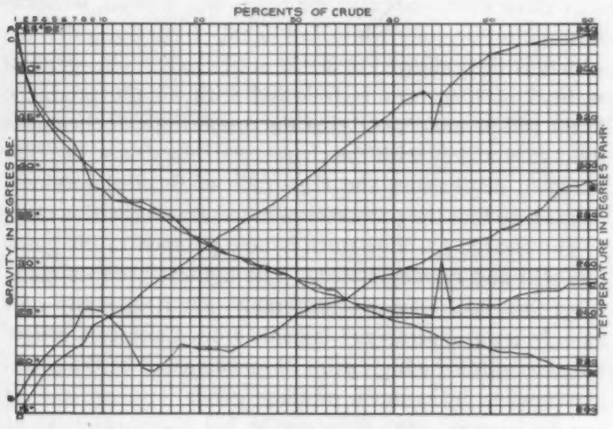


FIGURE 7.

The heavier hydrocarbons of petroleum do not, however, distill unchanged under ordinary conditions, but decompose into lighter compounds, gas and coke. To explain this process in full would be tedious even were it possible, but it may be said in brief that one substance of high boiling point and low gravity may be decomposed by overheating into two or more lighter and lower boiling liquids, often with attendant formation of permanent gas and free carbon. At comparatively low temperatures, such as may exist in the still, these products of decomposition are largely liquids of the various unsaturated series of aliphatic compounds; at higher temperatures the yield of gas is greater, and at red or higher heat the liquid products of decomposition are principally of aromatic series, such as are found in gas tars, and similar to those of coal tar.

As the liquid products of decomposition are, in the case of California oils, quite valueless in the finished products, being rather impurities which must be removed in the treatment, great care is taken to prevent this decomposition. Two methods are used to this end, one to distill in a partial vacuum, which greatly lowers the boiling points of all the petroleum hydrocarbons; the other and much more widely used method is to inject a current of steam into the still. The steam acts mechanically by displacing and lifting the heavy oil vapors from the still, thus lowering the boiling point and preventing overheating. On the plat (Figure 7), the curves *C-C* and *D-D* show the fall in gravity and the rise in boiling point on a sample of the same oil spoken of above, but in this case distilled without the current of steam. On comparing these curves the effect of the steam is readily shown. On the temperature curve *B*, where steam was used, there is a strong drop in temperature from the eighth fraction, where the steam was started, to the fifteenth, where equilibrium was reëstablished. From here on the rise was almost unbroken, though not very steady, to a maximum of 286° on the sixtieth fraction. Where steam was not used the rise in temperature is much more rapid and steady, up to the forty-third fraction. Here the still was stopped for several hours, but the break does not represent the natural cooling of the still during this time, as all temperatures were taken while still was running, but the lowering of boiling point occasioned by decomposition while cooling and reheating. You will note that there is a corresponding rise in the gravity curve, due to the same cause. Taking the curves *A* and *C*, representing the gravities, you will note that they are practically indistinguishable up to the forty-sixth fraction, no decomposition of moment taking place up to this time, but beyond this point the tendency of the curve of dry distillation is upward, the decomposition more than offsetting the natural fall in gravity, while the tendency of the steam distillation curve is constantly downward. You will readily see how great an influence the manner of running the still will have on the final products, and how variable the yield may be from one and the same oil with differing treatment.

Fractionation.—The fractions or "cuts" made in distilling crude petroleum are regulated by the gravity. That is, the gravity reading at which the products will have the desired properties is found by experiment, and these average gravities adhered to in running. But as it is not practicable to repeatedly test the distillates in the tank, the initial and terminal gravities of the cuts are used. For instance, suppose that in running a certain crude oil we found that kerosene stock should have the gravity 42° Be. We also find on trial that by running into our kerosene tank all the distillate after the gravity reaches 52°, until it has reached 38°, we get a mixed distillate having the gravity 42°. The stillman then uses these cuts in running the still until it is found that they no longer give the required average gravity, as may be the

case if the supply of crude oil changes. If the distillate then averaged too heavy, either the initial or terminal cut would be raised, if too light either or both would be lowered. The fixing of cuts must be done anew for each crude oil, and is often a very complicated and delicate matter.

A Sample Run.—To illustrate the actual running of a lot of oil, let us take an oil of 26° gravity, the manipulation of which is outlined on page 8 of the blue prints. The crude is pumped into the crude still, and the fire started. Soon the distillation commences, the first distillate reading perhaps 70° in gravity. This first distillate is directed to the gasoline stock tank and kept running there until the gravity at the sight box has fallen to say 52°, when it is turned into the kerosene stock tank. In the meantime the temperature in the still has been gradually rising, and when it reaches say 250° F., a very slight stream of steam is turned into the still. The stream flowing from the condenser will now greatly increase, but the temperature of the still will also fall, and the flow of distillate soon settle back to normal proportions. The quantity of steam is gradually increased as the distillation progresses, the amount used being a matter of judgment with the operator, but usually being, in the last stages, a considerable proportion of the stream flowing from the condenser. The water condensed with the oil is allowed to flow into the cut tank, and drawn off from time to time as it settles.

When the gravity of the oil flowing through the sight box reaches 38° the stream is turned into the stove oil tank, at 30° into the fuel oil tank, at 24° into the lubricating stock tank, where it flows until the distillation is finished. These last oils, from 24° on, are very strongly subject to decomposition, and the gravity of the last runnings from one oil may vary from 26° to as low as 12°, according to the method of running, and the amount of steam used. For instance, if no steam were used, but the distillation forced hard, the final gravity would probably be about 24° to 25°; if the still were run more slowly, without steam, the gravity would perhaps be 26° to 27°; if the distillation were carried out at normal speed, with a moderate amount of steam, the gravity at the end would range from 22° to 18° according to the efficiency of the still and condenser; while if the still were run very slowly with a large steam supply, and under the most favorable conditions, the final gravity might be as low at 12° Be.

The distillation is finished when the asphaltic residue in the still reaches the desired hardness. This is found by drawing out a small sample from time to time for testing. When the proper grade is had, the fire is shut off, but the steam allowed to flow into the still until distillation of oil ceases and only water flows from the condenser. Steam is then shut off and the asphalt drawn out into the cooler, to remain there until cool enough to draw into barrels. As soon as the still is empty, it is cooled by blowing in steam for from one to three hours, and when sufficiently cool is refilled with crude and a new distillation commenced.

Finishing.—We now have in our cut tanks:

Gasoline stock	about 60°
Kerosene stock	about 43°
Stove oil, raw	about 33°
Gas or fuel oil	about 28°
Lubricating stock	say 22°

and in the cooler, asphalt.

The gasoline stock would be pumped to the agitator and mixed by air pressure with about 1 per cent. of its volume of sulphuric acid, 66° Be. The acid is generally added to the oil in two portions, one being settled and withdrawn before the other is added. After thorough mixing of acid with oil, say for twenty to thirty minutes, the air is shut off, and the acid, which is now black and tarry from substances dissolved from the oil, allowed to settle. It soon collects at the bottom and is drawn off, at small works into a drain, at larger plants into tanks to be worked up in various ways. The acid being entirely removed, the oil is repeatedly washed with water, then mixed with about the same quantity of a dilute solution of caustic soda. This being agitated, settled and withdrawn, the oil is again washed with water until the washings show no further alkaline reaction. The oil, which is now almost or quite white, but cloudy from finely divided water, is then allowed to settle until clear. This general method of treatment is followed with all the products, but it will be understood that the proportions of chemicals used vary widely with the character of the crude, the care taken in distillation, and the grade of finished products desired, so that the proportions stated are suggestive only.

The cleared gasoline stock is now pumped to the gasoline still and refractionated. The lightest product made from this stock varies considerably, but it is rarely that as light a gasoline as 72° is made from California crude. On account of the high price of gasoline and of the products next to it, as much of these goods is turned out as can be squeezed out of the crude, but the percentage of gasoline proper is usually rather small. After the gasoline is off, a benzine cut of from 63° to 60° average gravity is made, and the last of the distillate is run to the engine distillate tank. Practically no residue is left from this distillation, and no steam is used until near the end of the run, often none at all. Because of the danger of fire, steam in closed coils immersed in the oil is often used as a source of heat instead of direct fire. Gasoline and benzine are usually sold as they come from the still, engine distillate also in the lower grades, though the best qualities are sometimes given a light second treatment.

Kerosene stock is treated in the same manner, from 1 per cent. to 2 per cent. of acid being used. It is then settled and pumped to the kerosene still. Figure 8 shows the course of kerosene through the refinery, the apparatus used in this part of the work being shown in a continuous line, though of course it is not actually so arranged.

The kerosene still is arranged like that for crude oil, but is usually of smaller size. Steam is turned in as soon as distillation commences, and the distillate turned into

tedious to you. It will be enough to sketch the outlines of the processes used in the manufacture of commercial lubricating oils.

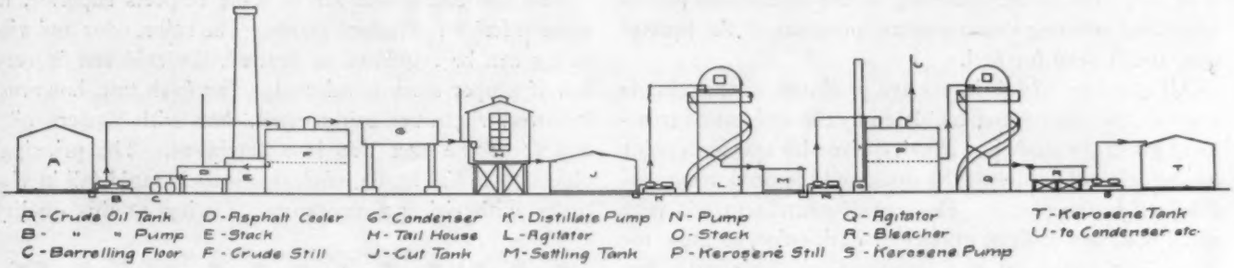


FIGURE 8—SHOWING THE COURSE OF KEROSENE THROUGH A REFINERY.

engine distillate tank. The principal requisite of a salable kerosene is the proper flash point, next the proper gravity. As distillation progresses the gravity of the residue falls, while its flash point rises. A sample is drawn from the still from time to time, and as soon as the proper figure is reached, the fire is shut off, and the still allowed to cool. If the gravity is not right when the desired flash point is attained, a change must be made in the cuts of the crude stills.

When cool, the kerosene is pumped from the still to the kerosene agitator, and again treated with acid, alkali and water. This treatment requires some skill, and great care, as the finished kerosene must be of good odor and quite colorless. When treated, the kerosene is passed to the bleachers, and warmed by blowing in wet steam, when it rapidly settles clear. When perfectly clear and bright the kerosene is ready for the market.

The next cut, stove oil, which finds some use in household stove burners, is treated with acid and alkali for high grades, or with alkali alone for low grades, considerable being marketed without any treatment whatever. The market for this article has never become well enough established to have any very definite requirements.

Between the stove oil and that suitable for lubricants, there is always an intermediate oil which yields no products of value to redistillation or treatment, and which is therefore used for fuel. The gravity of this oil will vary with the quality of the crude and with the cuts made. In running light oil and separating the lubricants, the gravty of the fuel cut will be somewhere about 28°, but if the lubricants are run into this fraction the gravity will be lower. The refineries at Bakersfield turn out great quantities of a distillate of about 26°. This is straight-run distillate, that is, the entire run of oil from start to finish. As Kern River crude contains no distillate lighter than stove oil (a trace of kerosene excepted) this distillate is very similar to one made by running together the fuel and lubricating fractions from a lighter oil.

The lubricating stock is treated in such a great variety of ways that go exhaustively into the subject would be

The lubricating fraction of the crude, having a gravity of from 24° down according to circumstances, contains impurities which must be removed by chemical treatment, as well as volatile decomposition products which must be separated by distillation. To effect the first, the stock is treated with sulphuric acid, in proportions varying from ½ per cent. up to even 10 per cent., then with water, alkali and water, as with other oils. This chemical treatment is comparatively simple when the lighter stocks are treated, but the treatment of heavy stocks is a very tedious and difficult matter, because of the strong tendency of the chemicals to emulsify with the oil. Such emulsions settle very slowly, in fact, in very bad cases they can be considered actually permanent. The oil is kept warm to maintain its fluidity, and the chemicals are added in small doses, care being taken to avoid too thorough mixing.

The oil having been treated, and washed until the last traces of the alkali disappears, is settled until clear, being kept warm during this process, and then pumped to the lubricating still. Here it is distilled very gently, with a large steam supply, until the residue in the still has the proper gravity, viscosity or flash point. The fire is then withdrawn, but the steam allowed to flow into the still until temperature is considerably reduced. The hot residue is then drawn through a cooling worm immersed in a water box, into the storage tank.

The regulation of a lubricating oil distillation is a very nice matter, requiring great skill and care. The color of the residue may very readily be darkened by overheating during the distillation, while both flash point and odor will be depreciated if the oil is allowed to cool too far in the still, as in this case the decomposition products which are constantly forming will condense on the cooler upper portion of the shell, and run back to foul the oil. The residue from the still may, if pale oils are desired, be again treated, though this is a difficult matter with heavy oils, or may be filtered through beds of fuller's earth or bone coal.

The distillates from the lubricating stock may, if a considerable portion of the stock has been distilled off, be

again treated and reduced to make a very light bodied oil, though oils made in this manner have not the lubricating value of those made by direct reduction of the stock. If the distillate is too light to be handled in this manner it is of very little value, consisting in this case almost entirely of foul smelling decomposition products of the heavier oils, and is used for fuel.

All gravities of lubricants are produced in this simple manner, the color being regulated by the amount of treatment given the stock, the gravity, viscosity and flash point by the original nature of the stock and the proportion distilled off in the re-run. The cost of manufacture is very small with oils of light gravity or dark color, as these require light treatment and comparatively little care, but the manufacture of heavy oils in pale shades is expensive, requiring considerable apparatus and time, much skill, and the greatest care and circumspection in all parts of the work.

Commercial Products.—On account of the absence of solid paraffins from our oils, the products of our refineries are limited to the burning and lubricating oils, and asphalt. Many of our oils contain no gasoline, even the best but a small quantity, and that not of the lightest. Probably no gasoline lighter than 72° is produced in this State, the larger product being from 70° to 68°, but the quality is very superior, the odor being exceptionally pure and sweet, the volatility considerably higher for any given gravity than with Eastern gasoline, and the heating value somewhat higher.

The yield of kerosene is also comparatively small, while the quality is not strictly the best. The color is satisfactory, the odor excellent, but the burning qualities rather low, there being some tendency to burn yellow or smoke, probably on account of the higher percentage of carbon. This defect, however, does not prevent the refineries of this State from finding a market for their entire output of kerosene at an excellent price.

The lubricating oils are in some respects superior, in some inferior to Eastern goods. The color, odor and viscosity can be regulated as desired, the cold test is very low if proper stock is selected. The flash test, however, is lower, viscosities being equal, than with Eastern oils, and for some uses this is a detriment. The principal objection to California lubricants is their rapid fall in viscosity with rising temperature. Owing to this quality

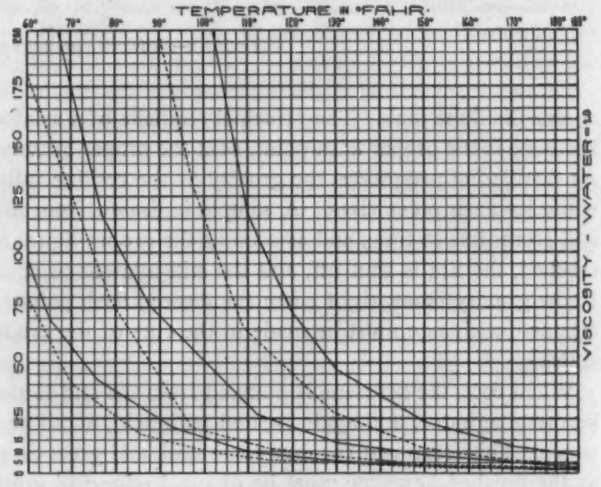


FIGURE 9—A COMPARISON OF THE VISCOSITIES OF OILS AT VARIOUS TEMPERATURES.

they rapidly lose their lubricating value on a heating bearing, and in the heavier grades the fault is so pro-

TABLE 4—ANALYSES OF CALIFORNIA CRUDE OILS

District	County	Gravity	Gasoline	Kerosene	Middlings	Lubricants	Asphalt	Loss	Remarks
San Mateo	San Mateo	48.8°	50.3	29.7	3.2	12.8	.0	3 5	
Colusa	Colusa	15.2°	.0	.0	35.0	56.0	6.0[a]	3.0	[a] Not True Asphalt
Moody's Gulch	Santa Clara	38.0°	25.0	45.0	15.0	11 0	3.0	1.0	A "Paraffine" Oil
Sargents	Santa Clara	17.2°	1.0	9.0	23.0	38.0	27 0	2.0	
Bitterwater	San Benito	42.7°	31.0	37.6	12.6	15.0	Trace	3.8	Green Oil
Coalinga	Fresno	33.4°	20.0	12.0	38.0	29.0	Trace	1.0	Green Oil
Coalinga	Fresno	28.1°	15.2	17.0	31.3	21.5	12.0	3.0	
Coalinga	Fresno	21.4°	1.8	15.0	27.7	35.5	18.2	1.8	
Coalinga	Fresno	16.1°	.0	2.0	22.5	52.0	21.7	1.8	
Coalinga	Fresno	12.4°	.0	.0	12.8	40.7	34.8	.0	
McKittrick	Kern	18.9°	0.7	12.1	30.9	31.8	22 6	1.9	
Midway	Kern	17.1°	.0	2.0	21.3	36.6	36.7	3.4	
Sunset	Kern	14.0°	.0	2.0	25.0	38.0	32.0	3.0	
Kern River	Kern	14.0°	.0	.0	21.1	40.0	35.2	3.7	
Santa Maria	Santa Barbara	27.6°	25.9	21.5	18.8	20.0	12.0	1.8	
Summerland	Santa Barbara	15.0°	.0	3.0	28.5	40.5	32.2	3.8	
Ventura	Ventura	25.6°	12.4	19.2	21.4	19.0	25.3	2.7	Contains Paraffine
Ventura	Ventura	11.8°	.0	.0	24.3	32.3	41.7	1.7	
Newhall	Los Angeles	42.7°	52.3	25.8	9.9	.0	.0	2.0	White Oil
Newhall	Los Angeles	17.2°	0.5	12.1	23.8	35.7	25.9	2.0	
Los Angeles City	Los Angeles	15.7°	.0	3.0	33.2	35.1	25.7	3.0	
Whittier	Los Angeles	21.0°	2.8	14.4	23.1	34.1	21.4	4.2	
Puente	Los Angeles	26.8°	15.4	24.7	16.4	18.0	24.0	1.5	
Fullerton	Orange	34.5°	25.7	25.1	12.1	21.3	12.9	2.9	
Fullerton	Orange	20.5°	4 4	12.3	18 4	34.7	25.9	4.3	
Chanute	Kansas	31.4°	3.0	31 5	30.5	25.0	6.0	4.0	No Paraffine
Spring Valley	Wyoming	41.9°	20.5	34.0	30.0	13.0	.0	2.5	Paraffine Oil
Beaumont	Texas	22.6°	2.0	13.0	36.0	36.0	11.0[a]	2.0	[a] Not True Asphalt
Lima	Ohio	?	16.0	68.0	.0[a]	16.0	.0	.0[a]	[a] Doubtful

OUTLINE OF REFINING PROCESS

Crude, 100%, 26°—Distill in Crude Still.

1—70° to 52°		
Gasoline Stock, 60°.....12.0%		Gasoline, 68°..... 2.5%
Treat in Stock Agitator, Loss.. 0.2%		Benzine, 60°..... 3.0%
Distill in Gasoline Still, Loss.. 0.5%		Engine Dist., 52°..... 5.8%
		Losses..... 0.7%
2—52° to 38°		
Kerosene Stock, 43°. 17.0%	Raw Kerosene 13.2%	
Treat in Stock Agitator, Loss.. 0.1%	Treat in Kerosene Agitator and bleach, Loss..... 0.1%	Engine Dist., 52°..... 3.5%
Reduce in Kerosene Still, Loss.. 0.2%		Kerosene, 42°.....13.1%
		Losses..... 0.4%
3—38° to 30		
Stove Oil, 33.5° 13.0%	Treat in Stock Agitator, loss.....0.2%	Stove Oil, 34°.....12.8%
		Loss..... 0.2%
4—30° to 24°		
Gas or Fuel Oil, 28°.....20.0%	No treatment	Fuel Oil, 28°.....20.0%
5—24° to end of run	Distillate fit for fuel only	
Lubricating Stock, 23°.....24.0%	Residue may be of any gravity desired, precentage varies correspondingly. Residue may be again treated if desired.	Fuel Oil, 30°.....9.3%
Treat in Lubr. Agitator, Loss.. 1.2%		Lubricant, 19°..... 14.2%
Reduce in Lubr. Still, Loss.... 0.3%		Losses..... 1.5%
Residue		
Asphalt, Grade "D".....12.0%	No treatment	Asphalt.....12.0%
Distilling Loss..... 2.0%		Loss..... 2.0%
100.0%		100.0%

nounced that it has been found impossible, so far as I am aware, to produce a satisfactory cylinder oil from California stock. Figure 9 shows graphically a comparison between the viscosities of three California lubricating oils and three Eastern oils of similar initial viscosity, at various temperatures. It will be noted that the most important divergence of the curves occurs between 60° and 100° F., and that there is in these cases some recovery between 100° and 185°.

Table 4 on page 344 shows analyses of typical samples of crude oil from the various fields in this State. For comparison, analyses of samples of crude oil from Wyoming, Kansas, Beaumont and Lima are appended to this table. It should be stated that many of these analyses were made on small samples, and are not represented to be accurate to anywhere near one-tenth of a per cent. Some of the figures, asphalt for instance, are really accurate that far, and it was impossible to extend part without carrying all to the same point.

Chemistry of Petroleum.—The chemistry of petroleum in general, and of California petroleum in particular, is clouded with doubt, due more to the enormous extent of the subject and the great practical difficulties in the way of research, than to any lack of earnest and painstaking effort on the part of experimenters. Yet a number of disconnected facts have been determined, and while no general survey of the constitution of even one oil can now be made, these isolated facts may be of interest.

Petroleums may be broadly divided into three classes: the pariffin oils, found in the eastern United States, Canada, Roumania, Borneo, Sumatra and Burmah; the asphaltic oils, so called, found on the Pacific Coast, in Indiana and parts of Kentucky, in Germany and the Caucasus; and the terpene petroleums, found in Louisiana, Texas and one or two points in California. These general types are connected by samples of intermediate character, and the classification is at best quite arbitrary and inexact.

Paraffin oils are supposed to consist principally of hydrocarbons of the paraffin series (CnHpn+2) of which methane is the lowest member. These hydrocarbons are colorless, very stable, unaffected by air and light, very little acted on by even the strongest chemicals, and not readily decomposed by heat. Petroleum of this class generally, though not always, contains solid paraffin. Paraffin petroleums are found in California in Humboldt County and at Moody's Gulch in Santa Clara County, just possibly at other points.

The term "asphalt base" as applied to California petroleum has a very broad and uncertain meaning. It arose from the observation that most of our oils contain or yield asphalt, but as some oils in California which contain no asphalt are almost certainly identical with others which do contain it, the presence or absence of asphalt is no criterion. The term is most properly applied to a class of oils, to which those of California largely belong, which consist principally of cycloparaffins, hydrocarbons with closed chain and of the formula CnHn, of which trimethylene is a type. These hydrocarbons are intermediate in their properties between the paraffins and the benzine hydrocarbons found in coal tar. They are somewhat heavier, boiling points being equal, than the paraffins, slightly less stable, more readily acted on by air and by reagents, and more subject to decomposition by

heat. Petroleums of this class seem almost certainly to have been formed by destructive distillation of organic matter, and usually contain notable proportions of the benzine hydrocarbons. The oils of Russia, which resemble our oils very closely from the chemical standpoint, are said to contain very little asphalt, but it is characteristic of oils of this class that, any asphalt which may be contained in the oil being once removed, further quantities of asphalt may be produced from the pure liquid portion of the oil by heating or oxidation. The petroleum of Beaumont is very similar to those of California, though leaning a little to the nature of a paraffin oil, while the oils of Alsace and Hanover are even heavier than our oils, and contain larger proportions of the benzines.

The oils of Welsh, La., and of portions of Texas, are said to consist principally of terpenes, which are very heavy bodies, closely resembling the higher benzine compounds. We have in California at least one oil of this class, found in seepages in Colusa and Napa Counties. Such oils neither contain nor produce asphalt, are very little subject to decomposition or the action of chemicals, and are very heavy in relation to boiling point. As the chemical series to which these oils belong include no very volatile members, such crude oils yield no light products, but are ideal stocks for the manufacture of lubricants.

In spite of their great diversity of appearance and physical properties, there seems to be good reason to believe that all the oils of California, with the exceptions noted, are basically the same. The difference in appearance is due to the varying proportions of more or less volatile oils, and of asphalt, rather than to any inherent difference in constitution. For instance, the average Kern River oil is, as you know, a heavy, tarry liquid of high boiling point, while the light oil of Fullerton is a light, volatile liquid of totally different appearance. Yet careful reduction of the lighter oil to the gravity of the heavier yields a residue very difficult to distinguish from the heavy crude, and there seems every reason to believe that the difference in the two crudes is due entirely to the greater proportion of volatile elements in the lighter.

Again, the proportion of asphalt in oils of equal gravity is remarkably constant. That is, almost all our oils of any one gravity have been found to yield the same proportion of asphalt, within narrow limits, and furthermore, if the lighter oils are reduced by careful distillation, the residue will be found to contain very nearly the same proportions of asphalt as the average crude of the same gravity.

Many California oils contain solid paraffin, but few yield more than minute traces. The heavy distillates solidify at low temperatures, but pass from the liquid condition through that of a jelly, to an amorphous solid. When paraffin is present, it is rarely in quantity to cause solidification on cooling, but usually crystallizes out above the solidifying point. Many heavy oils become solid at very low temperatures without giving the slightest indication of crystallization under a powerful lens. The temperature at which solidfication takes place is, because of the absence of paraffin, much lower than that with Eastern products of the same viscosity, a property of great value in the manufacture of lubricants.

Owing to the nature of the compounds making up the body of our oil, all the products vary in their properties from those of products from Eastern or other paraffin oils. Boiling points being equal, the gravity is distinctly lower, from 2° on the light gasolines to 8° or 10° on the heavy lubricants. The kerosene fraction, from 150° to 270°, from an Eastern crude, would be from 47° to 49° gravity, from a California oil from 38° to 40°.

Viscosity being equal, boiling point, and consequently flash point, are much lower. This has a notable effect on the flash point of the lubricating oils, and indeed on that of kerosene, the burning qualities of which are practically limited by the viscosity.

Viscosity being equal, the gravity is much lower. A Pennsylvania lubricating oil of 30° gravity would in general have the same viscosity as a California product of 22°.

California oils are more subject to the action of air and sunlight than are Eastern products. An Eastern residuum, freed from volatile products, is almost permanent in the air, merely evaporating slowly, while a heavy California oil will, under the same circumstances, absorb oxygen and rapidly solidify. This explains the suitability of our oils and the valuelessness of Eastern oils for road-making purposes. The same property extends to all the products except the lightest gasolines, and while it is of no practical importance in the case of kerosene or the oils lying near it, when we come to lubricating oils it is an unfortunate feature, as they blacken and gum with some rapidity when exposed to the air.

California oils decompose somewhat more readily on heating than do Eastern oils, and the decomposition products are of less value. The heaviest portions of Eastern crude break down principally into olefines, which can be worked up, under certain limitation, into salable kerosene. The heavier portions of California crude break down perhaps more readily, but into heavier products (about 26° to 30°) of very little value, while when decomposition is carried farther, the volatile products are so highly unsaturated, so subject to the action of air and light, and of so foul an odor, as to be of no commercial value. So that while the heavier portion of Eastern oil is systematically decomposed or "cracked" to increase the yield of kerosene, in this State great pains are taken to avoid cracking, and to obtain as nearly as possible the products originally existing in the crude oil.

As noted above, hydrocarbons of the benzine series are found in California petroleum, but not in quantities of any commercial value, considering the difficulty of removal and the low price of such products. However, these oils are peculiarly susceptible to decomposition into benzine products, at or near red heat, and should the market ever demand a larger supply of these goods the demand could

readily be met, in any amount and at low cost, by the application of simple processes to our petroleum.

Compounds of sulphur occur in almost all California petroleums, but not in large quantity. The proportion of sulphur is rarely less than 0.5 per cent., nor more than 1.5 per cent. Part of this sulphur is probably free, but most appears to be combined, the sulphur compounds being volatile without decomposition. From the distillate the sulphur compounds are readily removed by the common acid and alkali treatment, no lead nor other special treatment being necessary as in the case of Ohio and other sulphur petroleums.

On heating California crude with sulphur, hydrogen sulphide is evolved and asphalt produced. In this manner asphalt may be made from any of the oils heavier than kerosene. Asphalt made in this way usually contains little or no sulphur and can not be distinguished from the asphalt naturally existing in the oil. It is highly probable that the presence of quantities of free sulphur have had much to do with determining the quality of some of our deposits of heavy oil, notably the shallower oils at McKittrick and Sunset.

On combustion with excess of air, the sulphur burns to sulphur dioxid, which has no action on dry iron or steel. In spite of a long-prevailing opinion to the contrary, the sulphur in California crude does not seem to be detrimental to boilers where our oil is used for fuel.

Basic compounds of nitrogen are found in our oil, almost without exception, in quantity ranging from a trace up to nearly 2 per cent. These bases are substituted ammonias, said to be of the pyridine series, are of no present commercial value, and are readily removed from distillates by the acid treatment.

Compounds containing oxygen, of acid nature, and allied to the phenols, are found in the distillates from all our oils. Their quantity ranges from a faint trace in the gasolines to 2 per cent. or 3 per cent. in the heavier lubricants. They are removed by the alkali, but are a source of some annoyance, as they form very viscous sodium salts (not soaps, though much resembling ordinary soft soap in appearance). These phenol salts are often insoluble in the dilute alkali by which they are formed, and the great difficulty found in separating the soda wash from lubricating oil is largely due to their precipitation, and emulsification with the oil and alkali.

In gas making with crude oil, the oxygenated compounds volatize with little or no change, and account for the trace of phenol in the tar. The nitrogen compounds are volatized unchanged into the tar, or at very high heat decomposed into hydrocarbons and nitrogen. Sulphur is the only impurity in the crude which notably affects the quality of the gas, being in part converted into hydrogen sulphide, in part into aromatic sulphur compounds which condense with the tar. Where the gas-making process is such that lampblack rather than tar is formed, the sulphur of the oil is necessarily found largely in the gas, and when using such processes, scrutiny of the sulphur content of the crude used may be reflected in purifying costs, particularly as the oils from closely adjacent wells often differ notably in percentage of sulphur.

EFFECTIVE STEAM PLANTS FOR GAS MANUFACTURE.

BY C. H. PENNOYER.

IN treating of the subject of this paper I shall confine myself to the presentation of a description of a modern steam equipment and the operation of the same in connection with moderate-sized crude oil gas works.

It has been brought to the writer's attention by means of papers read before gas associations that some gas manufacturing institutions having certain by-products that could not be commercially disposed of, considered that these residuals were, therefore, of no value except for fuel, and that for this purpose they were in excess of requirements. In consequence of this method of reasoning, no special attention was given to the steam equipment or its efficiency.

At the present period, with the modern methods of accounting in vogue in most well-regulated gas corporations, where an accurate account is kept and checked of all materials entering into the manufacture of gas, whether it be for gas making, blasting or boiler fuel, it becomes at once apparent that it is necessary to look well to economies in the generation of the steam used.

To be able to keep the cost of steam production at the minimum point we must have:

First—The best boiler for the work in hand.

Second—The furnace arranged to most economically handle the fuel to be used.

Third—Properly installed and well-insulated steam pipes, exposed boiler parts and fittings.

Fourth—Efficient translating devices, such as engines, pumps, etc.

Requisite No. 1. The Boiler.—This piece of apparatus should be of a good water-tube type, erected on a substantial foundation to prevent settling. I say water-tube boilers, because if of good design and well constructed, they are light, powerful, compact and well adapted to this work.

There are many forms which differ only in detail and method of construction, but all have the following parts and principles: The steam is separated from the water and stored in a drum which is comparatively large in order to secure a storage capacity for hot water and a large surface for the disengagement of the steam. A large portion of the heating surface is composed of tubes of small size containing water and steam. The tubes are connected by pipes to the steam and water drums and also to a mud drum at the bottom. The hot gases from the fire are conducted among the tubes and after losing a portion of their heat they come in contact with the steam drum.

The general advantages of a water-tube boiler are as follows: The heating surface next the fire facilitates the transmission of the heat and prevents overheating.

The draft area, which is limited in fire-tube boilers, is the whole chamber in which the tubes are inclosed. This permits sufficient time for the absorption of heat from the gases prior to passing into the stack.

Riveted joints are removed from the fire, a very desirable feature, since the double thickness of metal when exposed to the direct action of the flame causes serious difficulties; owing to their weakness, all strains of unequal expansion are concentrated there. The steam enters one end and leaves the other end of the drum, therefore the steam and water are completely separated. The water tends to circulate rapidly in one direction and it is due to this fact that the chance to deposit a sediment is reduced to a minimum. Water-tube boilers are rapid steamers, owing to the fact that the water is divided into small streams and is thereby brought into intimate contact with the heat.

Another feature is their safety. They possess good circulation, so that no part is exposed to the fire that is not covered with water. The water is so divided into small masses that serious results do not result in the event of rupture, since the thermal storage is small. The walls of the boiler should be so arranged that the radiation of heat by them will be as low as possible. The most efficient method of reducing this radiation is by means of hollow wall construction. The writer has had occasion to employ this method recently on two boilers erected at the San Jose Works, and the difference of temperature of the external surfaces of the bricks of two adjacent boiler walls, one being solid and the other hollow, is very appreciable.

The space intervening between the bricks of the two walls is about two inches. If the boiler is of the water-tube type, the drum should be well covered with blocks of magnesia or asbestos at least two inches in thickness.

At the San Jose Works of the United Gas and Electric Company there are installed two Babcock & Wilcox semi-marine boilers. These boilers were selected on account of their compactness, style of furnace (being well adapted to oil burning), ability to raise steam quickly, safety, and on account of the liberal steam space, enabling the rapid delivery of dry steam.

These two boilers are arranged in a battery, and in place of the steel till and asbestos-lined jacket or housing employed in marine work, the brick wall of the "landsman" is substituted. The tubes are arranged in nine sections each having seven 4-inch wrought-iron tubes 12 feet long. The steam and water drum is 42 inches in diameter by 6 feet 7 inches in length, and, together with the tubes, is built for operation at 160 pounds per square inch. Heating surface is 935 square feet and grate area 33½ square feet for each boiler.

The tubes of the semi-marine Babcock & Wilcox boiler incline toward the front of the setting, the mud drum being located directly over the front doors instead of at the rear as in the ordinary type of Babcock & Wilcox boiler. The advantages gained by this arrangement of the tubes will be spoken of later on under the head of furnace. All pumps, whether for feed-water or fuel oil, should be in duplicate.

An injector should be installed in case the unexpected happens. This piece of apparatus should not be used continuously, on account of its low efficiency as a pump. When feeding a boiler, it has a thermal efficiency of nearly 100 per cent., since almost all of the heat of the steam passes to the water. Where the water is bad, the feed-water should be taken from a tank in which the water has been mixed with a compound and allowed to settle the scale and impurities out of it. It is far better to prevent the impurities from entering the boiler by following this practice than to inject compound in with the feed-water and neutralize it on the interior of the boiler. If the steaming efficiency and safety of the plant is of importance, too much attention can not be given to the feed-water and the proper way of handling it. All plant managements should have their boiler water analyzed and proper preparations then employed precipitate the impurities. The exhaust of the blower engines and pumps should pass through a closed heater and the water therefrom should be taken to a hot well, where, after it has been filtered, it can be added to the water in the feed tank. The introduction of feed-water at a high temperature increases the economy and tends to prolong the life of the boiler. The injurious effects of unequal expansion are diminished when the feed-water is warmed and the saving of fuel is considerable.

Requisite No. 2. The Furnace.—If oil is to be the fuel used, a furnace arranged as indicated in the above described Babcock & Wilcox semi-marine type of boiler would be the most economical in point of fuel consumption. The lower ends of the tubes are in the reverse position of the standard type of Babcock & Wilcox boiler, being at the front, where the oil burners are introduced. From this it will readily be seen that as the chamber recedes it becomes higher with the upward incline of the tubes, increasing in volume, thus giving the sprayed oil an opportunity to become heated to the proper temperature for combustion before coming into contact with the tubes. We are thereby enabled to secure more complete combustion than if the oil were introduced into a furnace which contracted toward the rear and brought the unconsumed gases into contact with the comparatively cool tubes before being elevated to the requisite temperature for complete combustion. This furnace arrangement is called the "marine furnace," and its superiority over the standard furnace has been demonstrated to be from 8 to 10 per cent.

At San Jose lampblack is the principal fuel. This is burned in a manner similar to that employed in disposing of breeze, etc. A grate bar having slots one-half of an inch wide, in three sections, each eight inches long, and spaces five-eighths of an inch wide, being used. The lampblack is allowed to drain before being used and is then mixed with the heavy tar from the seals, and the

partially consumed and coked lampblack from the ash-pit. The unconsumed coke helps to separate the remaining water from the lampblack and assists in a more rapid ignition.

The lampblack contains 30 per cent. of water when ready for firing. One cubic foot of lampblack when taken from the box weighs 75 pounds, and when thoroughly dry weighs 30 pounds. When in this condition (*i. e.*, corrected moisture) it has a heating value of 14,200 B. T. U. per pound (Parr calorimeter). Each 1000 cubic feet of gas made will produce 16 pounds of dry lampblack, having a heating value of 227,200 B. T. U., which is equivalent to 12 pounds or 1½ gallons of 14 gravity oil in thermal value.

Requisite No. 3. Steam Pipes and the Insulation of Steam Piping.—The steam piping must be very carefully erected. Pipes should be large enough, well lagged, and calculated so that there is little friction and condensation. If the steam header or main pipe is long or large, provision should be made to take care of expansion and contraction, so as to prevent leaks and injuries to the pipe. A bend or elbow will allow the pipe to expand without injury to itself or boiler. The most common and best methods are the copper bend or inverted "U."

Particular attention should be paid to the covering of all steam pipes, headers, etc., encasing all overhead pipes with sectional magnesia covering. By comparison a bare pipe loses by radiation 85 pounds of steam per 100 square feet of pipe surface exposed (1 H. P.—30 lbs. x 2.819 for bare pipe) against (.400 x 30)—12 pounds for a pipe covered with one inch of magnesia.

Most gas works have more or less underground steam pipes which must not be overlooked. These should be carefully boxed and the boxing filled with some efficient insulation. In some instances charcoal is used, sometimes ashes, or at times a more expensive material. Oil gas plants making lampblack can well afford to use some ot this by-product for the purpose of preventing radiation of heat, for according to some experiments of Professor Ordway (Transactions of A. S. M. E.; also Circular No. 27 of Boston Manufacturers' Mutual Fire Insurance Co.), lampblack is a very good nonconductor of heat. Professor Ordway's experiment consisted partially of determining the number of pounds of water that could be heated 10 degrees Fehrenheit per hour through various substances one inch thick. Heat applied, 310 degrees Fahrenheit. The following is an extract from his list of tests:

Live geese feathers	9.6
Loose wool	8.1
Light carbonate of magnesia	13.7
Asbestos paper (wound tight)	21.9
Loose calcined of magnesia	12.4
Cork charcoal	11.9
Loose lampblack	9.8
Pine charcoal	13.9

From this we see, according to Professor Ordway's experiments, that we have in lampblack a very good material for filling boxes containing underground steam pipes, as it ranks third in the order of best insulators. It is, in fact, first, because of the low ignition point of the first two mentioned insulators of heat.

Requisite No. 4 Engine and Pumps.—The pumps for handling the oil should preferably be double acting, with metal valves, and of the style manufactured by the Worthington or Snow Companies. Boiler feed pumps should be of the best make available and outside packed and installed in duplicate.

Engines for blowers should be as simple and strong as is consistent with economical operation. The steam pipe supplying steam for their operation should be carried to the operating floor so that the operator may have control of all of the apparatus without being forced to take unnecessary steps. If the throttle control is mounted on a neat stand similar to the generator steam and oil control, it helps to enhance the orderly appearance of the generator room.

Exhauster sets can be made quite efficient by employing direct connected outfits with governing float.

For fans for supplying various pressures to the mains, small automatic engines can be best employed.

While electric motors may in some cases work out a saving in cost of operating a few of the auxiliary pieces of apparatus in and about a gas works, their economical utility in most instances is doubtful.

When it is taken into consideration that if electric motors are employed, steam engines and boiler capacity must still be retained for use in the event of interruption of the current supply. This means duplicate investment to begin with. Next we would probably have to work the boilers at a lower point of efficiency when the motors were operating in order to have ample capacity during an electrical shut-down. The cost of the additional fuel required for the driving of the auxiliaries would ordinarily amount to considerable less than the cost of the current for motors, even though we charged the current to the gas works at 1½ cents per killowatt-hour. For example, we will take a 5-horsepower engine operating ten hours per day and consuming 35 pounds of steam per horsepower per hour:

5 x 10 = 50 horsepower hours.

50 x 35 = 1750 pounds steam for 10 hours.

One pound of oil will evaporate under actual conditions not less than 10 gallons water:

$$\frac{1750}{10} = \frac{175}{7} \text{ pounds oil} = 25 \text{ gallons.}$$

25 gallons at 1½ cents per gallon = 37½ cents.

Five-horsepower motor operating same number of hours:

5 x 10 x 750 = 37.5 kilowatt-hours.

37.5 kilowatt-hours at 1½ cents = 56¼ cents.

These figures show an advantage in use of the steam engine over the motor amounting to 33 per cent. in this instance. If, however, it is a matter of convenience rather than economy, or if the needed power is at some distance from the boiler plant, then there is no other choice but the motor, as it requires so very little attention and is the cause of much less annoyance than a gas engine.

The writer regrets exceedingly that he is unable to give at this time a report of the comparative tests of a 54-inch x 16-foot horizontal tubular and a Babcock & Wilcox semi-marine boiler using both oil and lampblack as fuel.

AMERICAN VS. ENGLISH GAS COOKING STOVES.

BY A. S. MAIN, GLASGOW,. SCOTLAND.

AS our purpose in this paper is to contrast American with British gas ranges, it will be well in the first instance to describe briefly what we consider the typical gas cooking range of each country.

THE AMERICAN GAS RANGE.

The popular American gas cooking range is constructed with a baking oven on top and a roasting and broiling oven underneath; in the latter oven cooking is done by deflection from a gas burner placed on the top of the oven. The heat from this burner circulates round the outside of the baking oven placed above, so that the one burner does double duty. It is important to note that the products of the gas do not enter the baking oven, but simply circulate round the casing of same.

THE BRITISH GAS RANGE.

The typical gas range used in Great Britain is constructed with a large roasting oven, varying in height from twenty to thirty inches and ten to twenty-four inches in width. The gas is consumed in Bunsen burners placed on each side of the oven, and as close as possible to the bottom of the same. On the top of this oven is a separate hot plate with boiling rings and a broiling and grilling arrangement. The bulk of the ovens made in this country, and hired out by gas companies, are constructed with enameled steel plates inside, with an outer casing of enameled plates, or cast iron, the space between the outer and inner casings being packed with nonconducting material, which greatly economizes the gas consumption and gives better results in cooking. The American style of stove was made in Great Britain many years ago, but has been practically discarded in favor of the present system.

POINTS OF SUPERIORITY IN THE BRITISH GAS COOKER.

First—The oven is better adapted for roasting meat, owing to the direct action of the heat on the joint and the constant current of fresh air which is drawn in at the bottom of the stove and continually passing round the meat in the oven. There is obtained in this way, owing to the excellent ventilation and the constant air currents, the nearest approach to the old method of roasting before an open fire. In the American stoves the joint is baked, and not roasted, and as the oven is entirely closed there is a lack of ventilation which we in this country consider so desirable for good and wholesome cooking.

Second—The second point in favor of our British oven is due, we believe, to the fact that the products of combusiton of gas, consisting of water, vapor and carbonic acid gas (CO_2) are inside the oven. We believe that this moist heat gives better results in roasting and the juice is better preserved in the meat.

Third—We consider by our method of constructing one large oven we obtain greater economy in gas, as with the same consumption of gas we heat the large oven in which quite a variety of food can be cooked. In the lower portion meat can be roasted or a meat pie baked; in the center of the oven fruit puddings or pies can be cooked, and on the top, bread, light pastry or fish can be baked.

It may be thought that the mixing of flavors by the cooking of such a variety of articles in one oven would not give good results, but it has been proved, by frequent tests, that no matter how diverse the nature of the food may be which is cooked in these ovens, there is no absorbing of flavors by the different articles. Onions and light pastry have been cooked at the same time without the one tainting the other.

In the American oven, supposing grilling, broiling or toasting of bread is to be done, there is no doubt that the lower portion of the cooker will do this work very effectively, but it is seldom that one wishes to broil or toast and bake in an oven at the same time. Consequently there is a considerable waste of gas as compared with the British oven. In the British oven, the broiling or grilling burner is placed on the top, and the same gas which is used for toasting bread will boil the kettle or fry fish, bacon, etc. One can readily see that in the ordinary requirements of a household, boiling water, frying, toasting and grilling are more frequently demanded than anything else, and these are more effectively done on the British ovens than on the American.

OBJECTIONS TO THE BRITISH OVEN.

There is no doubt that many people have a prejudice against the internally heated gas oven, but we think a little consideration will show that this prejudice is founded on ignorance of the true nature of the process, both of the combustion of gas and of cooking food. We must bear in mind that meat in process of cooking is always exuding its juices and not absorbing. The late Dr. Stevenson Macadam, F. R. S., E. F. I. C., F. C. S., chemist to the Surgeon's Hall, Edinburgh, some years ago, at the request of the North British Association of Gas Managers, devoted special attention to the question of gas cooking, and as a result of his prolonged tests gave it as his verdict:

"That the wholesomeness of meat cooked in gas ovens must be regarded as beyond doubt."

Dr. Steel of Guy's Hospital, London, said:

"In gas cookery, the juices and fat, instead of being separated as in the ordinary process, become thoroughly incorporated with the meat—a point of great interest in a nutritive as well as a commercial sense."

Dr. Macadam further stated his experience of gas cookery was:

"That the osmazone of flavoring matter was better preserved in the meat when cooked in a gas oven than when cooked in a coal oven."

As we have stated above, the products of gas combustion consist practically of water vapor and carbonic acid gas, and it is a singular thing that people who will cook a chop or steak over an ordinary coal fire or on a coke grill, and consider it the best of all possible means of cooking, would object to place a joint in an internally heated gas oven. Now we know that in the gas oven the meat is subjected to the influence of the same products as the chop or steak which is cooked over the gas or coke fire, with this exception—that the coal gas used in the gas oven is purified of sulphur, ammonia, etc. Some who object to the presence of carbonic acid gas forget that in the coke grill, which is considered the most perfect means of grilling, the meat is surrounded by carbonic oxide gas (CO), much more deadly than carbonic acid gas. People who habitually drink sparkling waters (which are filled with carbonic acid gas) seem to have a fear of the same product when applied to meat, though, as we have pointed out above, meat in process of cooking does not absorb, but is continually giving off its gases. It seems to be overlooked that while an excess of carbonic acid gas is no doubt harmful to the respiratory organs, in moderation it is rather beneficial for digestive purposes.

With regard to the matter of ventilation of the ovens, I am quite confident that we are on the right side, and that for the roasting of meat especial'y, a constant current of fresh air is very beneficial. In the American stove the outer casing must get very hot when the stove has been in use for some time, with the consequent result that a great deal of heat is radiated from the stove. This is obviated by our system of packing the cooker, which not only keeps the outside cold, but economizes the gas. We made a test some time ago of a single-cased cooker against a packed cooker, and found the saving of heat to be nearly 40 per cent.

Regarding the difference in cost, I think this is due to the different ideas entertained in Britain and America regarding most manufactured articles. In America the idea seems to be that articles should not be made to last too long, as new inventions are constantly coming into the field, whereas with us, we feel the idea is to supply a substantial article with long life, and our cooking stoves are now made with cast-iron exteriors and enameled interiors, should be as good in twenty years' time as they are to-day, provided there is reasonable attention paid to cleanliness.

AMERICAN VS. ENGLISH GAS COOKING STOVES.

BY C. S. BARBOUR, LONDON, ENG.

I HAVE studied, with no little interest, the kind of gas cooker which finds acceptance on your side of the water, and, if I may be permitted to say so, in this matter the Americans do not appear to show their usual spirit of go-ahead-ism, if the illustrations you have sent me are representative specimens of your up-to-date gas cookers.

I will venture, therefore, to back up my statements with a few remarks by way of comparing your cookers with ours.

The form or general principle of a double oven of your kind was adopted by some makers years ago, in the infancy of the trade, but was discarded in favor of the single oven of similar capacity.

The reasons for this were:

(*a*) The inconvenience of having your joint down so low, with the trouble incidental to stooping.

(*b*) The fact that, the joint being so very near the burners, it had to be constantly watched, taken out and turned, which had all to be done in a most uncomfortable position.

(*c*) Restricting the area so that only moderate-sized joints could be cooked, whereas you can hang a very large one in the single oven.

(*d*) In the matter of gas consumption, there is no doubt that this was *far greater*, for a given result, in the old style of stove than in the new.

(*e*) *Bread and Pastry Baking.*—You can not get the top heat so essential to bread and pastry baking, in the upper oven, which will always be hotter at the bottom than at the top.

(*f*) The upper oven is surmounted by a chamber through which the air circulates. Now, this air is always saturated with particles of fat which form a deposit inside, and which can not be got at for cleaning purposes, and so is apt to cause an unpleasant smell.

Apropos of the above, I believe this form of construction was originally followed under the erroneous impression that meat and pastry could not be cooked together without the flavor of one being imparted to the other.

Construction.—I am not quite sure from the diagrams, but I believe you have not adopted our double-cased and packed system throughout the stove doors, sides and top, so that I am sure you lose much heat by radiation.

Durability.—Then again, I can not see how your type of cooker can have a very long life, as the gas fumes will soon eat into the casings of the stove. For this reason we enamel our internal cases, and, in our very latest patterns, we make these enameled plates removable; they can then be easily cleaned.

Hot Plates.—I notice that your patterns have extended hot plates, which are, however, only partially fitted with burners. On ours we increase the number of burners.

Burners.—We consider your burners have been *specially designed for the collection of dirt and grease,* causing them not only to choke, but the burnt accumulation to become offensive.

AMERICAN VS. ENGLISH GAS COOKING STOVES.

BY H. C. KEYES, SACRAMENTO.

NOT having been requested to read this paper on American versus English gas ranges until the eleventh hour, I have not had sufficient time to make any extensive inquiries or investigation relative to gas ranges of English manufacture, and I am therefore unable to take up this subject in as detailed and thorough a manner as I should like to. However, from what I have discovered of the various features entering into the construction of gas appliances manufactured abroad, and so far as I can determine from such information as I have been able to secure, I should certainly say that the American-manufactured gas range is so far in advance in every respect of the average gas range of English make as to hardly admit of comparison.

In the first place, I consider American-made gas ranges far superior to those of English manufacture in both general construction and appearance. When compared side by side the English article seems a very crude and cumbersome affair, as it is constructed throughout of very heavy castings. Furthermore, no allowances whatever have been made for producing lightness of weight in those parts which, to secure the best results, must become heated throughout quickly. It is very evident that it must take a great deal more gas to heat such a range through than it would to heat similar portions of an American range of the same size, and this also results in a needless waste of fuel. It seems to me, considering the amount of space which the English gas range takes up, it has not nearly the capacity of the American-manufactured range. Our ranges have the broilers underneath the baking oven, and one set of burners heats both ovens, thus making it possible and practical to broil and bake at the same time, and with a much less consumption of fuel as well as work, than would be necessary with the average English range. Again, the manufacturers of English gas appliances do not seem to be far enough advanced in their general knowledge of the proper mode of constructing such appliances, in so far that they do not incorporate in their construction numerous small features that are of great practical value, and all of which are found on the average American gas range.

On American gas ranges the spring-balance drop doors have been adopted, whereas the average English gas range is gotten up with a swing door fitted to the front of the range with very large, clumsy looking hinges of not very pleasing design, and fastened by means of old-fashioned handles or catches.

Furthermore, the top burners on the American-made range are distributed in such a manner as to secure the greatest possible utility in using a variety of different sized cooking vessels on them at the same time, whereas the average foreign range has the top burners so arranged as to make necessary the use of certain sizes only of cooking vessels in order to avoid rendering certain burners useless for the time being.

One of the main features on a gas range is the burners and valves, and in the construction of the English ranges we find that the old-style cored drilled burners and the old-style lever valves are still employed, whereas on our up-to-date ranges we have the removable cone burners and the adjustable needle valves.

While some ranges of English make are fitted up with such improved features as oven lighters and simmering burners, nevertheless these are not nearly as late in construction as those used on American-made ranges.

Furthermore, I consider that the adjustable air mixers on the domestic gas ranges one of the most valuable and important adjuncts and far superior to the stationary affairs used on English ranges.

And still another important feature—the American gas range can be purchased at about half the cost of an English gas range of similar size and style.

And last but not least, we must take into consideration the matter of finish and appearance, and while our American gas ranges are of handsome design, nicely proportioned, and fitted with ornamental nickel trimmings and nickel-plated valves and valve-strings highly finished, we find the average English gas range is a very plain looking article indeed, having just a plain black stove-finish, with perhaps here and there a nickel knob or perhaps a nickel name-plate.

SOME PRACTICAL OBSERVATIONS ON THE FLOW OF GASES IN PIPES.

BY L. P. LOWE.

SINCE the inception of the gas business until almost to the present time very little more than passing thought and attention has been given to the subject of the flow of gases in pipes, superintendents and engineers of gas companies making and delivering artificial gas having been more or less satisfied with existing conditions, and when troubled with an insufficient gas supply to consumers have temporarily removed the difficulty by laying additional or larger sized gas mains, while still retaining the initial low gas delivery pressure given by the gas holder.

For this condition two cardinal reasons have been principally responsible, one of which has been the very strong prejudice existing against the use of anything but cast-iron pipes for street mains, and the other the general belief that if manufactured gases were subjected to even very slight pressure it would cause a loss of illuminating power, this loss supposedly so rapidly increasing as pressure increased that if but, say, a few pounds were applied, a total loss of illuminating value would be the inevitable result, and, as "candle power" then meant everything, a mere suggestion of increase of pressure was looked upon as being heretical and even traitorous.

True it is that the natural gas man and the pipe manufacturer have laboriously and unfailingly taught the value and success of wrought pipes and high pressure, but it was argued that natural gas was not manufactured gas, and prejudice—that black bigot, that hideous demon, that irrational zealot, that witch-burning retarder of the world's development—could easily be depended upon to do the rest.

It is not, however, to the discredit of our brethren of the gas fraternity that this Rip Van Winkle, slow awakening, condition existed, for it must be remembered that we are, to a man, more or less " from Missouri, and must be shown ", bearing in mind the fact that with the locomotive came the objection that the poisonous fumes belching forth from the stack would destroy the birds and fowl of the air; the fact that the first fire engine of Philadelphia, throwing sparks from its funnel, was deemed more dangerous than beneficial and was pushed by the mob into the Delaware River; the fact that the world's future highway vehicle, the automobile, is even now being stoned in the streets of New York; the fact that the " carbonic oxide " cry has not yet ceased, and countless thousands of other such facts, due wholly to hateful prejudice.

True, it is that our very instincts of self-preservation compel prejudice; we draw it from our mothers' breasts and the very marrow of our bones fairly reeks with it, and for some unaccountable reason it would seem to be one of nature's laws that progress and enlightenment must be by a slow, very slow, process of evolution.

But think it over, study the question, try and look ahead do not place a one-cent piece so close to the eye that it hides the dollar just beyond, give the thought of the " other fellow " some of your thought, and be as little prejudiced as possible.

It goes almost without saying that a gas to withstand compression and delivery under high pressures, in a commercially successful manner, must be, as nearly as possible, a " fixed " gas, and this requirement at once raises the question as to what is a " fixed " gas. As a matter of fact, the term " fixed ", as applied to gases, is tautalogical as a true gas can not be otherwise than fixed and permanent until it is dissociated, or changed chemically, as by burning.

A gas may be physically, or mechanically, changed and it is a very common and everyday practice to do so in a commercial way. For instance, by application of high pressure, ammonia gas is liquefied and largely used in refrigerating processes; carbonic acid gas is also liquefied and very extensively used and the now well-known liquid air is another instance, but notwithstanding the changed appearance of the gases so compressed and liquefied the condition is merely a physical and temporary one and lasts only as long as the enforced conditions are maintained.

Physically all gases have what is known as their " critical " point, that is to say under changed conditions of temperature and pressure they assume liquid form, this critical point, varying greatly, however, in the different gases. Upon release from enforced pressure and return to normal physical conditions the composition of the gases will be found to be the same as before compression thus proving them to be true and fixed, or permanent, so far as physical or mechanical conditions are concerned.

With the case of vapors the conditions are entirely changed as vapors are constantly changing their physical conditions. For instance steam, or water vapor, when released into the atmosphere, rapidly returns to liquid form, and every gas man knows, or should know, that generally speaking the water taken from drip-pots was once suspended in vaporous form in the gas. It was never " fixed " or it could not have changed its form physically, for broadly speaking, none other than physical conditions can exist in gas pipes.

What has been said of condensation of water vapors in manufactured gas applies as well to the tarry and oily substances sometimes found in gas pipes. These substances were never fixed gases, being nothing more nor less than hydro-carbon vapors and which ultimately condensed.

A vapor may be fixed into a gas, but the term " fixed " as applied to gases is a troublesome misnomer which has unfortunately attached itself to the nomenclature of gas literature and probably to stay. Possibly no better term can be found to distinguish high-class manufactured gases, the constituents of which are almost wholly permanent ones, from the vaporous concoctions of fake gas promoters, and for public use it may be a good word, but as gas engineers, superintendents and managers, let us not misunderstand the term.

There are seven generally recognized constituents of manufactured illuminating gases, as follows, their common names being used:

1. Hydrogen (H_2)
2. Oxygen (O_2)
3. Nitrogen (N_2)
4. Marsh Gas (CH_4)
5. Carbonic Acid (CO_2)
6. Carbonic Oxide (CO)
7. Heavy Hydro-Carbons ($Cn\,H_2\,n$)

The first six of the gases in this list are permanent ones and usually comprise from 90 to 95 per cent. of the entire volume. The seventh constituent, the heavy hydro-carbons (sometimes called " illuminants "), is a complex mixture of a number of olefine, or oily, gases, all of which are also permanent, and in addition there is usually a small percentage of oily vapors which escape entire fixing in the process of gas manufacture and subsequent removal in the washing, scrubbing and condensing operations.

As the cleansing process of manufactured gas usually compels its intimate contact with water, and as, upon completion, it is stored in gas holders over water, it is not surprising that it should, and does, hold as much water vapor as possible in mechanical suspension, the

amount depending upon the pressure to which the gas is subjected, barometric or otherwise, and its temperature.

It will thus be observed that good manufactured gases contain two constituents which can be, and are, removed more or less completely by compression, one of which is hydro-carbon vapor and the other water vapor. Both are in very small percentage quantites and in a well-made and permanent gas the loss in illuminating value can only be very small, but if, perchance, the gas be of a kind which owes its value largely to unfixed vapors, it is then not a good one to compress as all vapors, whether hydro-carbon or water, will be condensed to liquid form and thrown down just as water is when squeezed from a fully saturated sponge, and the greater the amount of "squeeze" or compression, the more completely will the vapors be condensed. Compressing gas is, in fact, a good condensing and cleaning processes.

The flow of gases in pipes is governed by five factors, they being the specific gravity, initial pressure, terminal pressure, length of pipe and frictional resistance, all being more or less controlled by local conditions.

For many years gas men depended upon the well-known formula of Dr. Pole, in calculating the quantity flow of gases in pipes, which formula is as follows:

$$Q = 1350 \times D^{5} \sqrt{\frac{D \times P}{S \times L}}$$

Where —D = internal diameter of pipe in inches.
Where —P = pressure of gas in inches of water.
Where —S = specific gravity of gas (Air = 1)
Where —L = length of pipe in yards.
Where —Q = quantity of gas in cubic feet per hour.

So far as it goes, this formula is very useful, but its limitations are soon reached as it fails to take into consideration the fact that a volume of gas occupies a space in direct proportion to the number of atmospheres pressure exerted upon same. An "atmosphere" is 14.7 lbs. or say 15 lbs., as it is so considered in practical calculations where extreme accuracy is not required. If a cubic foot of gas at atmospheric pressure is subjected to an additional "atmosphere," say fifteen pounds shown on an ordinary pressure guage (for instance in a cylinder fitted with a piston) its volume will be reduced to one-half cubic foot. If now an additional "atmosphere" of pressure be exerted (say thirty pounds guage pressure) the original one cubic foot will be reduced to one-third cubic foot, and so on until the point of liquefaction is reached, which, however, will never be the case in the practical delivery of illuminating and heating gases for commercial uses.

It will be noted from the above that by compressing gas a very much greater quantity of what is known as "free gas" (that is, measured at atmospheric pressure) can be placed in a vessel of a given size than the actual cubical contents of the vessel. For instance, a tank which will contain 1000 cubic feet of gas at atmospheric pressure will, at a gauge pressure of say fifteen pounds, as explained above, contain 2000 cubic feet, and at a gauge pressure of thirty pounds 3000 cubic feet, and so on, and as this factor is not taken into consideration in the Pole formula, it is useless in connection with what is now known and recognized as high pressure gas delivery, but very useful and comparatively simple if only ordinary gas holder pressures are to be considered.

Several years ago, when the writer first set about seeking a reliable formula governing the flow of gases in pipes under very heavy pressures and over distances running into the hundreds of miles, he found an almost entire lack of general, and very little individual, information on the subject.

Eastern natural gas men were appealed to, and while some were obliging and courteous to the extent of calculating and giving answers to specific problems, none would furnish his formula, which he seemed to treasure and hide within his bosom as though of untold value.

Manufactured and natural gases are, however, nothing more nor less than elastic fluids, such as air and steam, and fundamental information was sought in these fields, with the result that, step by step, a formula was developed which was thought to be reliable, and which is as follows:

$$Q = C \times \frac{P + 14.7}{14.7} \sqrt{\frac{D^{5} \times (P_1 - P_2)}{.0761 \times 5 \times \frac{P_1 + 14.7}{14.7} \times L}}$$

Where P_1 = initial gauge pressure.
Where P_2 = terminal gauge pressure.
Where S = specific gravity of gas.
Where D = internal diameter of pipe in inches.
Where L = length of pipe in feet.
Where C = a "variable constant" (for value of *C* see note below).
Where .0761 = weight of one cubic foot of air at atmospheric pressure.
Where Q = cubic feet of gas per minute at atmospheric pressure.

NOTE: Values of constant *C*:

Diameter of pipe in inches...	½	2	3	4	5	6	7	8
Constant.....	36.8	52.7	56.1	57.8	58.4	59.5	60.1	60.7
Diameter of pipe in inches...	9	10	14	16	18	20	22	24
Constant.....	61.2	62.1	62.3	62.6	62.7	62.9	63.2	63.2

It will be noted that in this formula the constant (C) changes (if it may be so explained) with pipes of different sizes, owing to the very greatly increased frictional resistances in pipes of small size. If only a single constant is used a formula is not reliable until pipes become of such large size as to permit of the use of such a single constant.

It must be remembered, however, that notwithstanding the fact formulæ are empiric, that is, developed from experience, they become largely theoretical owing to local conditions, and must be accepted as such.

This particular formula may be said to have been proven owing to the following incident:

The writer, in seeking practical information governing the transmission of gas through long, high pressure lines,

discussed the subject at length with an Eastern engineer who has deduced a natural gas flow formula from about twenty thousand observations made at different line points during an entire winter, recording gauges having been probably largely used. A gas flow computer had been worked out from the information secured and replies could, therefore, be, and were, immediately given to numerous hypothetical queries, though an inspection of the computer, which was one of the slide rule type, was not permitted.

Subsequent comparisons of this practical information were made with calculations from the above formula, and found to so nearly tally as to be almost identical, and this formula is, therefore, looked upon by the writer as being reliable so far as knowledge, born of the present state of the art, permits.

The formula is based on pipe lines constructed of wrought pipes joined with ordinary screw fittings and contemplates straight runs without sharp, right angle bends which destroy the kinetic energy of the flowing gas and thus greatly reduces the efficiency of operation.

Much has been said and written, but very little has been understood and appreciated, on the importance of preserving to the utmost practical extent the kinetic energy of flowing gas, and as the term is one but seldom used it may be well to explain that by kinetic energy is meant the power stored in a moving object which keeps it in motion after the source of power has been removed. By way of illustration, conceive a railway train rushing along a straight, level stretch of track, the train being driven to its power limit. If the source of power, say the steam pressure, is now suddenly removed by closing the throttle, the train will continue to run, or "coast," for a long distance, due to its kinetic energy, gradually reducing in speed until the energy is exhausted and the train stops.

Consider now the same illustration, save that as the throttle is closed the train "coasts" along a level track having numerous curves of various degrees. Each curve absorbs a certain amount of the kinetic energy of the train, the short and sharp ones using more than the long and easy ones, owing to greater frictional resistance. If the train is driven rapidly over these same curves each one becomes a thief of power, the shorter ones stealing more than those of long sweep.

These are homely illustrations and scarcely scientific as descriptive of kinetic energy, but they will serve the purposes of this practical paper.

So it is with the flow of gas through pipes, and if the flow is derived at the expense of mechanical power it means increased cost of operation when the ordinary short bend fittings are used, and a saving when long sweep fittings are adopted, and the longer the sweep the greater the saving.

As an illustration, let us assume a four-inch pipe one mile in length through which it is proposed to deliver gas of a specific gravity of .450, the initial pressure used being ten pounds and the terminal, or final, pressure being 0, or that of the atmosphere. If this pipe is laid on a level and in a straight-away length without bending, the amount of gas delivered per minute (as determined by the formula) will be 564 cubic feet. Assume now the same conditions save that at a one-half mile distance the pipe turns at a sharp right angle and runs an additional one-half mile:—to deliver the 564 cubic feet as with the straight-away example the pressure required will be 10.9, an increase of 9 per cent. Assume again that in the one mile length three sharp bends are used:—under these circumstances a pressure of 11.3 pounds will be required to deliver the 564 cubic feet per minute, or an increase of 13 per cent. over the straight-away example. The increase of pressures required is due to the loss of kinetic energy, which will be very much lessened if the long sweep fittings are used.

As pressures increase the percentage loss is even greater; for instance, if the same example is taken as above save that instead of using an initial pressure of ten pounds, a pressure of fifty pounds is used with a terminal pressure of 0, the delivery of gas through a straight-away section will be 2050 cubic feet per minute, while, if in the same length of pipe there are three sharp bends, the amount of pressure required to accomplish the same gas flow will be 60.3 pounds, an increase of 20.6 per cent.

The problem of high-pressure gas delivery is just now attracting much attention from the gas engineering fraternity and several more or less reliable high-pressure formulæ governing the flow of gases in pipes have been published. As in the case of the formula given above, they almost all involve a calculation of the fifth power, and as this calculation is somewhat of a tedious one, Mr. F. H. Oliphant, a natural gas engineer and expert, has given a formula in Volume 6, pages 548 to 594, of the Ohio Geological Survey Report, from which formula has been eliminated the fifth power calculations, and which is as follows:

$$Q = 42\,a\sqrt{\frac{p_1^2 - p_2^2}{l}}$$

where Q = cubic feet per hour as above p_1 and p_2 are gauge pressures plus 15 pounds at intake and discharge ends of line and l is the length in miles. The factor a is found for various sizes of pipe in the following table:

d; Inside.	a	d; Inside	a.	d.		a.
				Inside.	Outside.	
0.25	0.0317	5	60	14.25	15	863
0.50	0.1810	5⅝	81	15.25	16	1.025
0.75	0.5012	6	95	17.25	18	1,410
1	1.00	8	198	19.25	20	1 860
1.5	2 93			Riveted or cast iron pipe.		
2	5.92	10	350	20	...	2.055
2.5	10.37	12	556	24	...	3,285
3	16.50	16	1,160	30	...	5.830
4	34.10	18	1,570	36	...	9,330

This last formula is for a pipe of one inch diameter and as the delivery increases more rapidly than the square

root of the fifth power of the diameter the cube of the diameter divided by 30 is added to this radical. Where the gravity of the gas varies, the quantity found is multiplied by the square root of 0.6 divided by the square root of the gravity as determined.

Problems worked by this formula, as against the more elaborate one given above, show that when gas is delivered at comparatively low pressures, say up to ten pounds, the results are very nearly alike, but as pressures increase, and especially when they become rather high, say in the neighborhood of 100 pounds, the results show a considerable difference, the formula given by the writer showing a greater amount of gas delivery than the one given by Mr. Oliphant.

For many years the flow of gas in pipes was very much of a mystery to the writer, who, so to speak, longed to get inside and see what was going on, and it was only a little more than a year ago that his curiosity was satisfied, and then in such a simple manner that it is surprising the illustration is not generally known. Before recognizing it, however, it was necessary to learn and accept the fact that, broadly speaking, the general laws which govern the flow of gases in pipes are the same as those which govern the flow of water.

Standing one day in a gas works wherein there is rather an intricate system of water troughs extending from various parts of the gas-making apparatus and finally connecting in a common outlet, it was noticed that the arrangement of troughs bore a certain resemblance to an ordinary gas main system and, therefore, the action of the various streams of water were carefully noted, with the result that it was evident anyone can easily gratify a desire to study the phenomenon of the flow of gas through pipes by merely building a system of small open water troughs showing about the same connection fittings as would be used in a gas main system.

The "banking up" and retarding of the flow is shown at the sharp bends and also the ease of passage over long sweeps. The lack of pressure on a "dead end" can also be clearly shown, and if in the sides and bottom of troughs imperfections are made representing joints of pipe, the eddies set up by reason thereof will clearly show the great value of having as smooth an interior surface as possible. If the experimenter cares to take the trouble he can also drop a few iron borings on trough bottom and note what happens to gas flow by reason of the borings dropping on pipe bottoms at points of service connections, and, with less trouble than it takes to make similar connection to a gas main, he can see what happens when the end of a service pipe projects into the main. If he likes he can also introduce particles of sawdust into the flowing water which will assist him in more easily observing the swirls and eddies and also permit of an interesting study of the frictional loss at sides of trough by noting the slow moving particles at sides as compared with the rapidly moving ones at center of stream. It is all very interesting and well worth the effort.

It seems almost unnecessary to call attention to the fact that the manufacturers' stated sizes of pipes are only nominal and not actual, and that the pipes known as "casing" (as well as boiler tube weights), as usually carried in stock, are designated by their outside and not inside dimensions, but it is only the inside dimensions which count in gas flow.

The practical lessons to be learned in pipe-laying so as to afford the best conditions for the flow of gas are: Procure a pipe having smooth interior surface; protect it as well as possible against corrosion; lay it in a careful manner and in such a way as to give as smooth and flush inside joints as possible; use long-sweep fittings, even if they must be specially made, and in making service or other connections, see that the main pipe is not obstructed thereby.

FROM A CONSUMER'S STANDPOINT.

BY JNO. A. BRITTON.

IF you will brush away the cobwebs from your memory and revert in thought to the past, there will no doubt be recalled to your mind a scriptural injunction which has something to say concerning the removal of the beam from your own eye before you endeavor to remove the mote from your brother's. This is another way of stating that it is desirable that a man should put himself in another's place, and also to remind one of that immortal saying of Bobby Burns. The active gas man, whether he be behind the counter or mixing with the customers in the capacity of collector, statement taker or meter setter, is very apt to regard himself as entirely in the right when there may be chances of error on his part and right upon the customer. As in all other pursuits of life, there is no assurance that we can so conduct our business daily as to be certain of a uniformity in our methods, or our manners; nor, on the other hand, is there a certainty that the consumer against whom we run possesses the same uniformity of condition. A badly cooked breakfast, an aching tooth, a corn on the toe, a scolding wife, a bad case of indigestion or a night out with the boys the evening before, may all tend to make the consumer who enters your office with a complaint irascible, unreasonable and disagreeable. Your clerks and attaches may be in the same frame of mind from similar conditions. It is safe to assume that every consumer who complains has good cause. Generally it will be a local one, or it may be the result of a stirring up by contact with his neighbor. It may be the fact that there was presented to him this month a bill for $4.50 as against a bill for the previous month of $2.40, when neither he, nor his wife, nor family, can discover any reason why the bill for that month should have been more than the previous one. He honestly believes that he has used no more gas either for fuel or illuminating purposes; in fact he has been more economical than usual, has retired earlier, has had no company, or has been out visiting a large portion of the nights during the month; and his mind immediately becomes distorted with

the idea that there is a bunko game afoot and that he is the particular sucker who is being buncoed by the irresponsible meter, and may God bless the meter's soul, for it has more sins to answer for than any other piece of mechanism invented by man. Building upon a proposition of defective registration there necessarily in his mind follows two series of conditions:

First—That the gas is poor and the pressure is bad; second—That the stove does not give out any heat, and smokes; and between the time that the bill is received and the time that he reaches the office he has thought out all sorts of problems and conditions and is loaded to the guards with what he believes to be facts, and perhaps we know deep down in our hearts that there is some cause for his complaint. We may know positively that the pressure did drop off the night before; that a little bit of thin gas got into the holder through some error of the gas maker; we may know that there is a drip upon his line that should have been pumped out the day before yesterday, but as soon as he begins to make his complaint up goes our hands in a defensive attitude and we are ready to box him off to the best of our ability. He sometimes succeeds, but more often we will talk him into paying the bill, and he goes away, as Dooley says, "With murder in his heart." We know (as this is a confessional we may as well be frank with each other) that in 90 per cent of complaining cases the consumer has some foundation on which to build his complaint. Why not, then, put ourselves in his place, look at it from a consumer's standpoint and acknowledge to him frankly that we are in error and have our faults, and instead of demanding the usual pound of flesh give him some panacea for the wounds that we have unconsciously inflicted and which are smarting under his thought of injustice, instead of pouring salt into the wound and make it doubly agonizing. I know this may be regarded somewhat in the line of preaching and of the manifestations of a superior character of virtue; that it is possibly self-adulation, but isn't it fair? Every seller of a commodity, from shoe-laces to houses and lots, endeavors to make friends with his customer by polite and careful attention and to gain his good will before consummating his trade by attractive methods and selling him goods at reasonable profit. We should remember that a consumer of every gas company is an integral part of the community in which he lives; that he has an influence, large or small, for good or for evil, and that his good graces should be cultivated to the extent of giving him credit for due honesty in his complaint and in his arguments. Naturally the ideal condition would be to so conduct the business that no one might have cause for complaint, but we all know that from the gas maker to the general manager that there is a long train of human intellects, that all are liable to error, and while the intentions may be the best, it is simply an impossibility to have them work in synchronism. Once in a while some of them get out of step; perhaps it may be the man who is sent out to repair a leak; perhaps it may be an unguarded word of the collector, a sharp retort of your office man, or a bilious condition of your general manager, but they all tend to the same cause, to antagonize. Why not then so endeavor to conduct ourselves, and by force of precept and example so as to educate those who are in charge of our affairs to realize that the consumer is the one who furnishes the funds to make the business profitable, and as such he is entitled, upon the ground that he is a stockholder in your output, to be considered as reasonable in his demand. I am necessarily excluding from this condition the class of people that are met with everywhere who are unreasonable always, who can never be satisfied with honest explanations of difficulties, and whose hands are against everything and everybody. These men need a different sort of treatment; it requires the whirlwind, sledge-hammer convincing positiveness to override and subdue them. These, like the poor, we have with us always, but they are very much in the minority. If we will be alive and awake to our own shortcomings; if we will be honest with ourselves when we analyze conditions and know that we are at fault; if we will be willing to confess that fault—not only to ourselves but to our consumers—and then set about a correction of those faults, and be careful that the fault is not too often repeated, we can gain good repute with our consumers, and having once gained their esteem by truthful and honest exposition of your affairs by a fair and equitable concession to them when in the wrong, establish such a record that as time goes on complaining, dissatisfied customers will melt away as does the dew before the morning sun. It would be a good proposition if the gas men could be placed in the position occasionally of being consumers of some other gas company. It is a well-known fact that there is no class of people more intolerant of errors in others than those who are constantly in error themselves. The greatest sticklers I have ever known in the gas business, and most unreasonable men to argue out a proposition of right or wrong concerning gas matters, have been men who were at some time or other in their lives associated with some gas company. To close as I began, remember the scriptural injunction to get the board out of your own eye before you attempt to remove the shavings from your brother's.

QUESTION BOX.

QUESTION: What gravity of oil is most efficient in crude oil water gas manufacture?

ANSWER—With California oil, about 14° B. The heavier the oil the better the result, but heavier than 14° is difficult to handle.

QUESTION: For what reason is the condensers left out in the crude oil water gas process?

Is napthaline formation any the worse by using scrubber alone?

ANSWER—Owing to the requirements of the gas-making process the ordinary condenser is unnecessary.

Naphthaline formation is no worse by reason of discontinuing use of condenser. The writer considers it less so.

QUESTION: Has any member used in the manufacture of crude oil water gas oils of different gravity? If so, have they kept strict account of the relative value of each for gas making; *i. e.*, the number of cubic feet of gas made per barrel from the different grades or gravity of oil? What are the results shown?

ANSWER—Yes, all grades have been used and the lower grades have given somewhat better results than the higher. Strict records have been kept, but are not at hand.

QUESTION: When making gas into an unweighed holder—exhausting from same (with varying steam) into a weighted holder—and supplying gas to the town, all at the same time, how can the amount of make be accurately figured, there being a difference in the atmospheric temperature of from 20° to 40° during twenty-four hours?

ANSWER—The above question represents emergency conditions, which should be remedied by the introduction of a station meter between the purifiers and the storage holder.

QUESTION: What is the significance of the official badge of the Pacific Coast Gas Association?

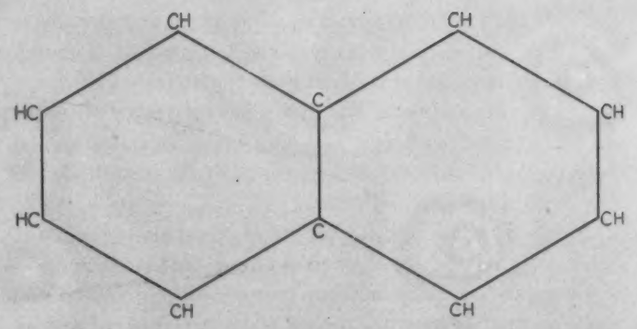
ANSWER—The origin of the seal of the Association was a small rosewood frame, carved by Mr. Edward Jones, superintendent of the South Boston, Mass., Gas Light Company, in the early days of the business, and is intended to represent a continuous line of pipe, representing a perfect circulation of gas—no dead ends, the ultimate aim and object of every gas man—and the burner in the center of the seal is emblematic of the point that every gas engineer works to—the ignition of the gas.

QUESTION: How can the same results, in the same length of time, be obtained from gas used for light, heat or power at 5000 feet above sea, as are obtained at sea level? A gas meter set to register correctly at sea level, will the same meter register correctly 5000 feet above sea level? If not, why not?

ANSWER—At an elevation of 5000 feet above the sea, the barometric pressure is about 24.8", or 5.2" less than at sea level. This reduces the atmospheric pressure about 2½ lbs. per square inch, and as the pressure is reduced gas becomes more attenuated, so that a thousand feet of gas at sea level would occupy a space of about 1174 cubic feet at an elevation of 5000 feet. If the 1000 feet of gas at sea level contained 600,000 British thermal units, then the 1172 feet at 5000 feet elevation would contain the same number of heat units, so that it would require theoretically 17.2 per cent. more gas to perform the same amount of work. This seems to be proven in practice, because the average gas used per consumer in Grass Valley, which is a mountain town at an elevation of about 2500 feet, is 1383 feet per month, while the average amount of gas used per consumer in Petaluma, which is a town practically at sea level, and of about the same size, is 1255 feet per month. These are both high pressure towns. A gas meter is set to register *volume* of gas correctly, and will register correctly in cubic feet of gas passing through it regardless of changes of temperature or barometric conditions, which may affect the relative density of the gas.

QUESTION: What is naphthaline?

ANSWER—Naphthaline C 10 H 8 is an aromatic hydrocarbon which was discovered December 15, 1819, by A. Garden, and formed in the distillation of coal tar. Afterward J. Kidd obtained the same substance by passing the vapors of coal tar through a red-hot tube, and gave it the name of "Naphthaline." (Phil, Trans. 1821, 209.) Its correct composition was first determined by Faraday. (Phil. Trans. 1826, II, 140.) It was first assumed that naphthaline existed as such in coal, but this idea was shown to be not accurate, but that naphthaline was a product formed by distillation. Erlenmeyer proposed the following formula, which consists of two aromatic nuclei which have two carbon atoms in common:



Naphthaline is sometimes formed by the condensation of hydrocarbons of the acetylene series. Berthelot found that by heating acetylene to a temperature at which glass softens, that a considerable quantity of benzine and naphthaline is produced. Naphthaline crystalizes in plates, has a characteristic unpleasant odor (well known to gas men), melts at 79.2° C. and boils at 218° C. Its specific gravity compared with water at 4° C is 1.145; at 80°, 0.9777.

QUESTION: One thousand feet of 22-candle gas will heat a certain quantity of water to the boiling point in five minutes; how many feet of 20-candle gas would be required, the same conditions to govern?

ANSWER—The quality of hydrocarbons which go to make up candle power is so uncertain and unstaple that it is only possible to give an approximate answer to this question. If the two candles increase was due to ethylene, there would be a difference of about 33,640 B. T. U. to the thousand feet of gas, or approximately 5.6 per cent., so that it would theoretically require 1056 feet of 20-candle gas to do the work.

QUESTION: How many gallons of water per hour should pass through a crude oil water gas machine making 5000 feet of gas per hour?

ANSWER—The quantity of water necessary for cooling and cleansing the gas depends in a great measure on the type and efficiency of the apparatus used for condensing and scrubbing. In one of the larger crude oil water gas plants, it has been found that 64 gallons of water were sufficient to condense and scrub the gas. This amount of water reduced the temperature of the gas to 60° F., and removed all solid suspended matter. In practice it has been found that 80 gallons of water per thousand cubic feet will cool and cleanse the gas satisfactorily. The amount of water necessary to produce 1000 cubic feet of crude oil water gas, including all water fed to the boiler for the making of steam, for gas making, and the operation of auxiliaries including boiler feed pump, oil pumps, pumps for handling, condensing and scrubbing water, exhauster and hoisting engines for cleaning out lampblack separator, but not including any water for condensing and scrubbing, amounts to 18.1 gallons, or 150.77 lbs. per thousand.

Weight of water used in this calculation American gallon of 231 cubic inches, weighing 8.3356 lbs.

QUESTION: When the total cost of gas decreases as the output increases, which are items of cost that decreases, and in what proportion?

ANSWER—If manufacturing conditions (which include ample storage capacity) are good, all the *fixed charges* (including labor for slight increase) should diminish directly proportional to the increased output.

QUESTION: What is the lowest candle power, and also the lowest calorific power of gas which it is advisable at present to supply present consumers with?

ANSWER—The introduction of the incandescent gas burner has completely upset the old relationship of candle power and light, so that the most economical gas for the consumer to-day would be a gas of low candle power and high calorific value, but as gas is still used in open flame burners, it has not been thought advisable to re-

duce the candle power below 16-candle power, although a gas of lower candle power and containing 600 or more B. T. U. per cubic foot will give better results per thermal unit in the Bunsen burners of heating appliances and incandescent burners for lighting, as it has been found that the higher illuminants which go to make up candle power will not develop their full theoretical thermal value when burning through a Bunsen burner.

In answering the latter part of this question, as to the lowest calorific power of gas which it is advisable to supply, it has been found highly inadvisable to distribute nonluminous water gas containing 300 B. T. U. per cubic foot, and the writer would suggest that it is to the best interest of a gas company and the consumer to supply a gas of high calorific value. A street main distributing system will convey more energy through given sizes of pipe of gas of high heating value than of a gas of low heating value.

QUESTION: When does the gas company's responsibility cease after laying street mains and streets are put back apparently in as good condition as before opened? If then, is it good policy to refuse to make repairs a year or two later when requested by the street commissioner?

ANSWER—The responsibility of the gas company does not cease at any time so far as the care of public streets are concerned. Good common sense should dictate to the manager the necessity for putting back the roadways in first-class condition, even better than they were when disturbed, and at the request of the street superintendent or commissioner keep the same in good repair whenever requested so to do. Be friendly with the "powers that be," and that will pay better dividends to a gas company than any other investment it can make.

QUESTION: To what if any are the objections to wrought-iron purifiers instead of cast-iron ones?

ANSWER—Cast iron was employed before steel construction had reached its present state of excellence. There can be no objection to the use of wrought iron or steel, if strains are properly calculated and provided against by reinforcement, and the metal is properly protected by paint.

QUESTION: Are all the plants in California making crude oil water gas affected by napthaline?

ANSWER—Naphthaline troubles are incident to all methods of gas manufacture. Somewhat so in California, but much less than elsewhere.

QUESTION: What has been the experience of the members with the Barrett Jack, manufactured by the Duff Manufacturing Company?

ANSWER—The Barrett Jack has become a part of our street equipment, whenever wrought-iron pipe is to be introduced either length ways or cross ways, much time is saved and a better job done. A saving in the sharpening of picks and renewals of shovels; it obviates the opening of long trenches and the filling of same. As we have forced 2½" pipe 190 feet, coming through within 3" of where pointed for, time one hour and a half, two men from the time of setting the Jack until pipe made its appearance at the far end. We have forced 4" pipe 56 feet under railroad (diagonally) where digging on trenching would not be allowed by railroad company, without evading legal questions.

Our latest is running a two-inch pipe 600 feet, digging 20' and forcing 40' alternately the whole distance, using the Jack as a macadam buster in the sections to be dug. The tool pushed along under the macadam raising it after the manner of a mole, leaving it ready for the shovel. No picks required.

Introducing services under cement sidewalks and meeting with brick or other foundations to be pierced, withdraw the forcing pipe and clean it, introduce it again, slip a smaller pipe saw toothed on the end, using it as a hollow drill and the forcing pipe as a guide, and proceed to drill.

Our experience is to use nothing smaller than a 2" pipe to force with where a straight hole is desired, a 2½" or 3" is still better in tough jumbo or adobe ground, roots, fence posts, brickbats, miscellaneous dumps and sometimes a tree we have surprised ourselves by passing through.

In obstinate cases we hitch a rope on the end of a five-foot lever, put three or more men on either side of the lever, and so far have never been stalled.

We are now engaged on a Siamese, or double, forcing arrangement giving a pressure of thirty tons and needing no extension pieces, laying the pipe as it goes.

QUESTION: What is the best purifier for a city government?

ANSWER—The best purifier for a city government is the active participation of the intelligent masses, more especially the commercial men, in the primaries and attendance at the polls upon the days of election.

QUESTION: What are the light units per gallon of California oil properly burned at the rate of five cubic feet per hour?

ANSWER—The writer is not clear as to the intent of this question, as the California oil used to make gas is broken up into the various constituent gases, some of which develop heat, and others heat and light, and all of the oil does not enter into gas itself, as a portion is converted into lampblack, and some is lost by radiation of heat. In oil gas making, where no solid fuel is used, 3.4 candles have been obtained per gallon of oil used. The following data concerning this oil may be of interest:

California petroleum, 14° B.
Specific gravity, 0.9722.
Weight per gallon, 8.10 lbs.
B. T. U. per lb., 19,916.5.
Ultimate analysis—Carbon 86.9, hydrogen 11.8, nitrogen 1.1.

QUESTION: To what causes are attributable the largest consumption of gas per inhabitant?

ANSWER—The complete equipment of kitchen with gas.

QUESTION: Who are the largest consumers of gas, the poor, the middle class, or the rich?

ANSWER—The rich are the best patrons of the company, considering total revenue received from both gas and electricity. The largest percentage of consumers are among the middle class.

EXPERIENCES.

BY R. P. VALENTINE.

The "Experience Department" has this year been slightly more fortunate than usual. I say "slightly" because our better success this year can hardly be called success, if compared with the possibilities of this branch of the work. First of all, the editor wishes heartily to thank those members that have so kindly furnished us with material. It was gratifying, indeed, to receive so many responses to our solicitations, even if the majority of them did consist only in expressions of regret. Upon the whole, the encouragement received by us this year promises well for the department, and is an undoubtable sign that the prosperity of the Association and the interest taken in the work is increasing.

It will perhaps, be appropriate first to submit the following bits of history—ancient history, I might say, for the events described took place between the years 1858 and 1866. It will probably bring to the minds of the older members present many of the trials and tribulations with which they had to contend in the early days, when the thousand and one modern facilities and conveniences were lacking.

Dipped in Tar.

At the Richmond Company's Gas Works, Staten Island, N. Y., 1858, Samuel R. Brick, Jr. Manager. We installed a Milesian named John Curley, as superintendent. Sometimes John used to get into a difficulty that would rattle him. On one occasion the drips under the center seal became clogged after dark. The purifying pans began to blow, so in his quandary he sent for Sam, who lived near by, and who happened at the time to be attired in an evening dress-suit for some function on the island. He came in a hurry. There was a trap door just ahead of the entrance to the purifying room, and a tar well immediately beneath it. Sam stepped in, went down to his armpits, was pulled out of the viscid mass and assisted in cleaning the drips.

His chief concern, after things were righted, was, "Where's my hat?" And to all queries concerning himself, his answer was "Where's my hat?" If that tar well is still in existence, the hat may yet be found. It was ever after used by the men as a word of caution, to notify each other as to the presence of Sam—"Where's my hat?"

Saved by Chance.

At the Manhattan Works, New York City—1859—the coal received from the ships was brought to the yard in dump-carts and dumped into a sheet-steel box, which rested in another steel box, snug-fitting, to prevent pieces of coal falling between them. Both tops were flush with the surface of the ground. The inner box held about two tons. When filled it would be hoisted, after the manner of an elevator, some forty feet, deposited on a four-wheeled truck and run along a track until opposite the place on the pile where needed. The box was then hitched on a trolley, run by gravity, out over the pile, the bottom sprung, and coal dumped. Several boxes were used, empties and loaded up and down. It was against orders for the men to go up on the elevator, for fear of an accident. This order was many times disregarded, and it so happened that one noon hour, after dinner, the cable broke when the car was about thirty feet high, with eight men and a full load, and, as a matter of course, down they went. Word was sent to the yard-master and weigher, who expected a few dead men and cripples to look after. It so happened, however, that the sudden fall compressed the air in the recess at the bottom of the elevator, forming an air-cushion and preventing a shock. No harm was done outside of a scare. This accident was the suggestion which led one of the then numerous elevator companies to take out a patent on a safety cage depending on the principle of a compressed air cushion.

Blasting Powder in a Retort.

At the Marysville Gas Works, California, 1864.—At the seven o'clock morning charging, I was standing in the retort house doorway reading the morning news, when suddenly I was blown out upon the sidewalk and the window slats blown into kindling-wood, Smudio, the stoker (a Mexican), was staggering, waving his arms, and on fire, but making no sound. I ran in to do what I could. He pulled me to the douching-tub, jumped in, rolled over to extinguish the fire in his clothing and then gasped for breath. This all happened in less time than it takes to tell it.

The Cause: About this time we were beginning to use soft Australian coal at the works, and, as we afterward found, blasting-powder from the mine, or ship's cargo, became mixed with the coal, as big as potatoes or small muskmelons. Smudio must have got a generous shovelful to have had such an effect, as his body was burned through three thicknesses of shirts. His eyes were saved by a broad-brimmed slouch hat that blew down over his face. The coal-shed was marked where the coal lay, as another cargo was being received. About a year after, we got back into the powder coal again. We watched for the marks we had made on the side of the shed, but they had been blackened by coal-dust and escaped our notice. At the eleven o'clock night charge Smudio was caught again. That ended his career as a gas man.

A Case of Osmosis.

At Marysville, 1866.—We were waited upon by Charley Patterson, superintendent of the water works, and asked if we had any water-pipe connected in any way with our gas apparatus. We informed him that we had the water connected with our washer. He said that we would have to make some other arrangements, as the gas got back into their pipes and the customers were complaining. We thought it queer, as we at the works had not noticed anything of the kind, and invited him to test for himself. He found it free from taste as to gas, but insisted that we should put up a tank.

While considering the tank proposition, the water works people discovered a damp place between First and Second, on C street, about two or three blocks from our works, indicating a small leak. In digging down to it they found the gas and water mains in the same trench and a strong smell of gas. They called out attention to it, and, by the way, it was in this part of town that the gas taste was complained of. We straightened up our pipe, which had settled in the damp spot, recaulked, and the contamination ceased. Could it be attributed to that seeming paradox of "endosmosis and exosmosis?" I have never heard of a case of the kind before or since. The water pressure had about 40 or 50-feet head (a little over twenty pounds). The gas pressure was about fifteen 10's. There is a nut to crack.

We will now turn our attention to the more practical experiences of to-day, which, though they can not claim the interest that we all manifest in the historical coal-gas process, are, nevertheless, of far more benefit to the gas man of to-day.

Naphthaline Stoppage.

Naphthaline experiences, we presume, are common, and the following will probably be of little interest. How-

ever, it caused us several hours of good hard worry. Having never had any experience with naphthaline, our distribution man reported back much disturbed, upon finding an unaccountable stoppage. The location of the trouble was a mile from the works, in an important three-inch main. After locating the stoppage as near as possible with the pressure gauge, we tapped the main, poured in a quantity of gasoline, and our trouble shortly disappeared. It has since occurred twice in the same place, and nowhere else on the system.

A Case Where Grit Failed.

I once had an experience with sand in wooden boxes, used to weight down the holder, thus increasing the pressure. The boxes were arranged around the edge of the holder and the sand piled in, during the summer. The device worked excellently during the warm months, but one night a heavy rain came and brought trouble. The boxes had been constructed tight and waterproof, but the hot sun had caused the wood to shrink until large gaps were developed at the joints; that is, this was the case with the boxes on one side of the holder. It did not take the rainwater long to discover the condition of affairs, and, conspiring with the sand in the boxes, it very shortly arranged a silent elopement through the loose joints. The result was, that when the weight was released from one side, the other sank until the holder was almost upon its side. Quick action alone prevented the loss of all the gas on hand. The high side of the holder was immediately anchored and we began to make gas to our full limit. In the meantime the sand-boxes were removed. In a short time the influx of gas righted the holder and we were safe again. It was not long, however, before the boxes were replaced and filled with cobble-stones.

An Expensive Bottle.

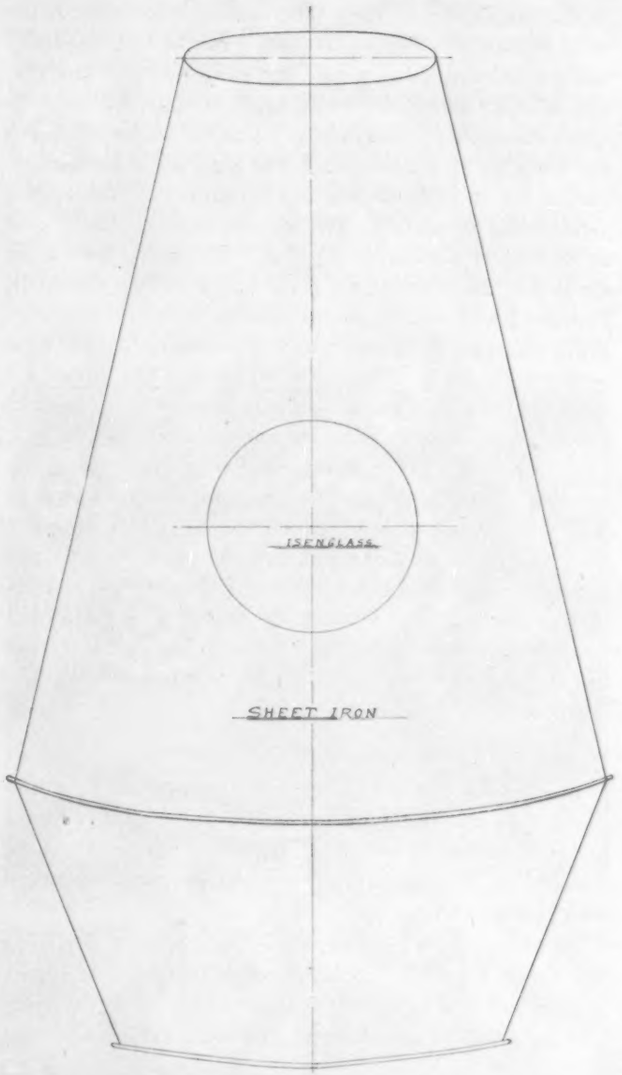
The following experience shows how a careless workman or an obtrusive bottle caused the expenditure of four thousand dollars. A four-inch main, three and one-half miles long, was laid to supply a small municipality at that distance from the gas works. The service along the line was at first excellent, but with the gradual increase in the number of customers the pressure decreased until it became so low that an immediate and effective remedy was demanded. It was natural to suppose that an increase in the size of the main would alone remedy the evil, and so it was decided to replace the four-inch main with an eight-inch one. The work was shortly undertaken, but had not progressed very far before the real cause of all the trouble was discovered.

After removing one of the lengths of the pipe from the ditch, a round bottle, to which adhered a quantity of tar, slid from the end near the bell. This is what had produced the fall in pressure. It was simply another case of "too much bottle." Notwithstanding the fact that the real evil was discovered early in the job, it was decided to complete the work, and the expenditure proved to be a fortunate one.

Equalization of Pressure.

Our plant operated for several years with two holders and two sets of mains, one being called the new or high-pressure (only four-inch, though), the other the old or low-pressure (two-inch). The low-pressure holder was situated some distance from the works and had to be watched in order that the inlet valve might be closed when the holder was full. This required considerable time, and, as our pressure from the old holder was not enough to give satisfactory service throughout, we weighed same to within two-tenths of the new or works holder, opened all the valves and united the entire set of mains into one system, connecting in where there were no valves. The old holder was equipped with blocks of wood securely fastened to the holder uprights near the top, so that when the holder filled to this point it remained full until the works holder was exhausted, when the old holder stepped in automatically. The change did away with our pressure troubles and the necessity of watching the old holder for the purpose of opening and closing the inlet valve. It works to a nicety.

Gas Fuel for Incubators and Brooders.



Proprietors of artificial chicken hatcheries have for years been looking for something more satisfactory, safer, cleaner and more reliable than kerosene to produce the little chick so wonderfully stored in the shell of an egg. Mechanical genius has placed the chick in a very independent position. In the shape of an egg, he is placed into an incubator and remains there for twenty-one days, when he breaks the shell and is then ready to fight the battles of existence. He gets no food for two long days and nights, and then the first that he indulges in is small particles of gravel, or grit. At the same time the little fellow is full of life and fully able to take care of himself, providing that his food is within his reach after the two days of fasing.

As a rule, the gas man is looking for business, and when his attention is directed to the application of gas in this large and open field, he manages in some way to accomplish his purpose. So it was with incubators and brooders. Gas is just what the chicken raisers have been looking for. To accomplish this purpose, the gas man has quite a responsibility on his hands for the following reasons: The gas must be of uniform candle power and must be delivered at an even pressure. The pressure, however, is the most important. The responsibility can be better realized when it is known that should the gas go out for any reason, without notice, the entire batch of eggs, which probably runs into the thousands, at a price of 40 cents a dozen are likely to be a total loss. The season for hatching is during the months of August, September, October, November and December. The burners most generally used in incubators are the No. 3 "B" Welsbach, with a tin shade like the drawing on page 349, and they should be furnished with a very fine adjusting valve, so that very slight changes can be made, as it is necessary that the temperature should be the same at all times. The device for heating brooders is a small boiler, generally made of sheet copper, with flues running through it to obtain the best efficiency. This boiler is connected with circulating pipes running through the brooder. The size of the burner depends on the size of the brooder. At a price of $1.00 per thousand cubic feet, gas will be used wherever available by the chicken hatchers, although it is slightly higher than kerosene. This kind of consumer is very desirable, for the reason that when gas consumption is lowest during the fall and winter months he uses the most, and is burning twenty-four hours each day.

An Experience With Purification.

Purification by modern methods has been made so simple that its cost is almost negligible, and the ready means of revivification of oxide of iron in the purifiers without removal or stirring has relieved the gas man's mind of many pangs of worry.

The purification goes merrily on, and when a purifying box shows a "color" on being tested by means of sugar-of-lead paper, it is evident that the oxide needs reviving, and the purifiers are changed, the cover raised, the plug placed in the top of the outlet pipe, and the steam jet exhauster begins the work of revivification by drawing air down through the oxide. Here is where the trouble begins. The process is too simple, and, in answer to the query, "How long does it take to revive the oxide?" the gas superintendent is apt to say one hour, two hours, three hours, or four hours, and sometimes it depends upon the amount of time available, or the time of day when the purifier is changed, and aside from the heating up and cooling down again of the oxide, due to the chemical action of reoxidation, there is no end point to show when the oxide is thoroughly revived and ready for use again.

This is a very long prelude leading up to an experience. The purifiers were changed regularly, one each day, and the revivification was applied with equal regularity, but at no time was the oxide thoroughly revivified, and, at the same time, the quantity of gas passing through the boxes was very erratic, so that when the greatest quantity of gas was passing through the boxes the superintendent was most actively engaged in other work, and, while the minimum of gas was passing through the boxes the superintendent had ample time to observe the purification, no sulphuretted hydrogen was carried forward, and the gas was well purified. When this condition was discovered, the purifying-house man endeavored to remedy it by a rapid rotation of changes, of revivification in place for shorter lengths of time, until finally he found himself with four foul purifiers. To overcome this difficulty, it became necessary hurriedly to remove the oxide from one box and replace it by fresh oxide, and then change the purifiers in regular rotation, and revive the boxes by drawing air through them for a period of four or five hours, until they were finally brought back to working condition.

The moral of the experience lies in the fact that the purification, having become so comparatively inexpensive and so simple, it is never necessary to have any of the purifiers badly fouled, and if two purifiers are changed each day and thoroughly revived, one in the morning and one in the afternoon, it insures a large factor of safety in purification and precludes any possibility of distributing unpurified gas. Also, it emphasizes the importance of testing the purifiers with lead paper at a time when the maximum amount of gas is passing through them.

Experience With Landslide.

A complaint of "No gas," and, at the same time, of "leak," was reported during April, 1904, by the residents in the neighborhood shown in photograph No. 2.

The company has a 4-inch iron main extending up the street shown in this picture, from which a 2-inch wrought iron main is taken at the street intersection marked with a cross, and runs up the hill to the left.

On uncovering the connection, it was found that the 2-inch pipe had been shoved to the right about 6 inches past the 4-inch main, pulling the nipple out of the top of

the 4-inch main, almost flattening the nipple. This was repaired and connected the same as before.

In a few days, another report from the same locality came, and, on uncovering the connection, it was found

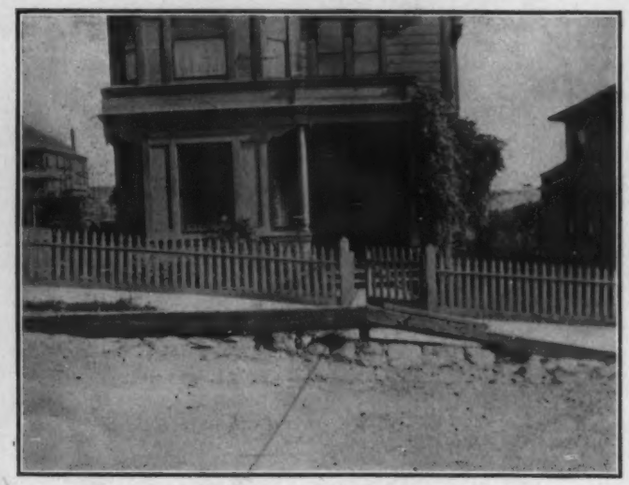


PHOTO No. 1.

broken as before. This time the 2-inch connection was made with elbows and nipples, so as to form a swing joint, and allow about 12 inches play. At the same time, the 4-inch main was uncovered for some distance below this point for inspection. About one hundred feet down the street from this 2-inch main, and opposite the point where the curb was buckled, raising it about a foot above ground, as shown plainly in picture No. 1 and indistinctly in picture No. 2, the 4-inch main was found raised and broken back of one of the bells. This was also repaired.

A few days later "leak" and "no gas" were again reported. The connection was uncovered, and the 2-inch pipe was found shoved past the 4-inch main and swing joint broken, which means the 2-inch main must have moved at least 18 inches. This was repaired by putting a tee in the 4-inch main and running the 2-inch main directly into it and connecting with a lead joint.

In a few days the street gang was again called in response to "no gas" and "leak" complaint from this slippery neighborhood. The 4-inch main was found to be broken back of the tee into which the 2-inch pipe was connected. This time the connection was repaired as follows: A 4x3-inch cast-iron tee was placed in the 4-inch main with the 3-inch bell looking toward the 2-inch pipe, a piece of 3-inch wrought-iron pipe, about 3 feet 6 inches long was made into this bell, and the 2-inch pipe was connected into this piece of 3-inch pipe with a lead joint, so as to form a telescope joint, allowing the 2-inch pipe to slide inside the 3-inch pipe, if sufficient pressure came. This joint is still doing business and the superintendent is indulging in a full night's rest.

Pictures No. 3 and No. 4 show some of the effects of the landslide on the nearby landscape. No. 3 was taken directly facing the original line of cement sidewalk, and shows the walk to have moved about a foot to the left; at the same time, the land was moving away from the camera, and the effect is shown on the house marked with a cross in No. 3 by the picture No. 4. The pressure is on the high side of the house bulging the chimney on the low side.

These pictures were taken one block away from our troublesome 2-inch connection, where the ground is about 40 feet higher. The land was sliding in two directions, west and south.

SAN FRANCISCO, CAL., July 16, 1904.

Mr. R. P. Valentine, Editor Experience Department, Pacific Coast Gas Association:

MY DEAR SIR: I am in receipt of your recent favor in which you ask me to furnish you with my experience with the use of corncobs for the preparation of purifying material, and while the experience which I have had with same scarcely warrants the preparation of information for your department, I am pleased to give you such information as I have so far secured.

As you are doubtless aware, the sawdust which is ordinarily procurable on this Coast, when used for the preparation of iron oxide, is not always satisfactory, and very frequently soon disintegrates to a very fine and powdery condition, notwithstanding that it may have been very coarse when first used.

In large gas works and those wherein relief holders are used, this pulverized condition of oxide does not make very much difference, but in small plants where gas is passed directly from the gas-making apparatus through purifiers and into the distributing holder, the fine purifying material causes considerable back pressure and annoyance, and necessitates more frequent attention to the purifying boxes than is sometimes convenient for the limited amount of labor employed in small gas works. This con-

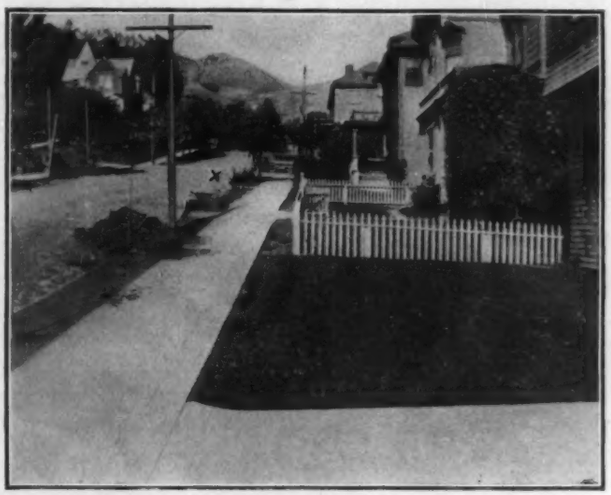


PHOTO No. 2.

dition of affairs has caused me to be constantly on the lookout for a support for iron oxide which will not disintegrate, and I have thought of many substances which might be used.

Some time ago I learned that corncobs were being used for this purpose in the gas works at Bakersfield, and subsequently Mr. James Goodwin, the manager of the Bakersfield plant, sent me samples of same.

PHOTO No. 8.

I determined to try the experiment of preparing iron oxide by using the ground corncobs in lieu of the sawdust ordinarily used and to try same in a works at Watsonville, which were then being built. The corncobs were procured with some little difficulty, and were ground in a very small mill which we borrowed from a farmer in the neighborhood.

The mill was operated by horse power, but owing to its very small size the work was very slowly done, and consequently attended with considerable expense.

The cobs were ground rather coarsely, the pieces ranging in sizes from that of a pea to say that of a hazelnut, after which the oxide was prepared in the usual manner from copperas and other ingredients, and, generally speaking, in accordance with the formula which Mr. E. C. Jones gave to the Pacific Coast Gas Fraternity several years ago.

In the preparation of the oxide it was found that the copperas solution did not penetrate so deeply into the corncob pieces as it does with sawdust, and therefore less copperas is used, which to a certain extent has an advantage, as the cost of copperas is somewhat less. I believe, however, the efficiency will be fully as great with the lesser amount of copperas, as with sawdust, which requires a greater amount, as the iron oxide which attaches itself to the surface of the particles is all that is of any value in the purification of gas.

The batch of iron oxide which we prepared as above was only recently made and has not as yet been put in operation, but I have every reason to believe it will work very nicely and will not disintegrate, and if such is the case it will result in doing away with the annoyance due to the use of very fine oxide.

I believe it would be well to seek the result of the experiment made by the Bakersfield people on these same lines, as for some time past they have been using iron oxide so made, while so far my experience goes only to the preparation of same.

If corncobs are found to be a desirable substitute for sawdust, it will, of course, be necessary to procure them cheaply and to also find an economical means of grinding same, all of which can, I think, be readily accomplished.

Trusting the above covers the points of your inquiry, I am, Very truly, L. P. LOWE.

SAN FRANCISCO, CAL., July 16, 1904.

Mr. R. P. Valentine, Editor Experience Department, Pacific Coast Gas Association.

MY DEAR SIR: It has occurred to me that possibly the members of the Pacific Coast Gas Association may be interested in learning of an experience with which I met while preparing for use several miles of wrought-iron pipe which was subsequently laid for street-main purposes at Watsonville, Cal.

As gas men are well aware, it is no infrequent occurrence to find lengths of pipe which come from the mills with imperfect welds, and consequently the seams are either open when received or not sufficiently strong to withstand the strains to which the pipe is subjected in ordinary laying and subsequent use, the imperfections existing notwithstanding the fact that the manufacturers of

PHOTO No. 4.

the pipe claim that each length thereof is hydraulickally tested before leaving the mills.

I therefore concluded to test every length of pipe before laying same, and as I wished to do so with a nonelastic fluid, such as water, I determined to use ordinary kerosene oil for the purpose, as water would have caused more or less rusting of the pipes, which would subsequently cause scale and other annoying troubles, stoppages of burners. etc.

In addition to preventing this difficulty, the kerosene oil would have a tendency to stop the action of any oxidation which might then be taking place in the interior of the pipe, and it would also lessen particles of existing scale, so that same could be readily moved before the pipe was laid.

The testing was done with an improvised apparatus consisting of an ordinary spraying pump, such as is used for whitewashing purposes, the suction of which was placed in a half barrel sunk almost flush with the level of the ground, and in this the kerosene was placed. Connections with quick-acting unions were placed on the outlet of the pump and the lengths of pipe to be tested were attached in such a manner as to permit of rapid removal.

The pipes were placed upon horses in a manner permitting one end to overhang the half barrel containing the kerosene, the further end being raised to a somewhat higher elevation, so that as the pipe was filled with kerosene all air was expelled. The further end of the pipe was closed with a fitting to which was attached a small valve, through which the air escaped, as the pipe was filled with kerosene. The operation of testing was as follows:

Several lengths of pipe were placed upon the improvised testing stand, as described above, and a gang of two men were employed in doing the work, one of whom attended to the pump and lower end of pipe, while the other attended to the further end of same.

The connection between pump and pipe was quickly made and coincident therewith the outer end of pipe was closed, save that the small valve on fitting was left open to permit of the escape of the air.

When all was in readiness the length of pipe was filled with kerosene by a few strokes of the pump, and as soon as the kerosene showed at the outer end the small relief valve was quickly closed, after which a stroke or two of the pump was sufficient to cause a gauge, which was attached to pump, to register from 150 to 200 pounds, this being the pressure under which the tests were made.

This pressure was maintained for a few moments by the man operating the pump, during which time his assistant passed along the length of the pipe, striking it sharp blows with a mallet, as is ordinarily done when making hydraulic tests.

The connection between pump and pipe was then removed and relief valve on opposite end opened, thus allowing the kerosene to return to the suction of the pump for repeated use.

As the kerosene was running from the length of pipe previously tested, the connections were made to a new length, and thus the work was very expeditiously and inexpensively performed.

Our experience in testing pipe in this manner proved valuable, as quite a number of defective lengths of pipe were found and discarded, in addition to which the application of the kerosene to the inside of the pipe was deemed to be very beneficial.

Very truly,

L. P. LOWE.

MEMBERS IN ATTENDANCE, TWELFTH ANNUAL MEETING.

Adams, H. E.
Alden, S. F.
Aldrich, W. A.
Alstron, W. F.
Arques, C. L.
Barrett, William G.
Beck, A. C.
Beggerstaff, E. K.
Boardman, W. F.
Britton, John A.
Brouse, E. H.
Burkhardt, H. W.
Byerly, H. O.
Carrigan, A.
Casey, Wm. J.
Chapin, W. W.
Cheffins, E. F.
Clark, O. E.
Clark, R. L.
Clements, John
Colquhoun, George S.
Conlinsk, C. W.
Cressey, Frank A.
Cressey, F. A. Jr.
Cushing, S. B.
deSabla, E. J.
Dill, W. N.
Doherty, H. L.
DuVal, William
Druffel, D. O.
Eichbaum, F. H.
Feist, Adolph
Fitzpatrick, F. E.
Froelich, Christian
Foveaux, Frank
Gillespie, W. W.
Godon, George E.
Grimwood, Charles P.
Grover, Sherwood
Guthrie, Samuel
Gunder, W. T.
Gutsch, A.
Hill, William H. P.
Holberton, George C.
Hollidge, George H.
Hughes, Charles
Jones, E. C.
Jones, F. C.
Kaneen, John S.
Kahn, Lazard
Keyes, H. F.
Kirk, George
Keyes, Henry C.
Leach, F. A. Jr.
Low, George P.
Lowe, L. P.
Lowe, S. C.
Lloyd, A. J.
Martin, John
Miller, C. O. G.
Malloch, Henry
Matthiesen, A. J. P.
Newbert, L. H.
Parker, T. R.
Pedersen, B. S.
Pennoyer, C. H.
Poingdestre, J. E.
Prutzman, P. H.
Quilty, C. W.
Randall, E. C.
Rice, A. L.
Riffle, Franklin
Roper, George D.
Ross, F. A.
Sterling, R. H.
Symmes, F. J.
Thomas, John W.
Thompson, George
Thompson, J. R.
Thompson, Robert J.
Vanderwhite, A. J.
Valentine, R. P.
Wanzer, H. S.
Weber, Hermann
Werry, John
White, W. A.
Wilson, G. W.
Wiester, W. H.

ASSOCIATE MEMBERS REPRESENTED, TWELFTH ANNUAL MEETING.

Hargreaves, Robert H.
Chico Gas & Electric Company, A. J. Stephens, Chico, Cal.
Colusa Gas & Electric Company, J. D. Kuster, Colusa, Cal.
Nevada County Gas Electric Company, John Werry, Nevada City, Cal.
Nevada County Gas & Electric Company, J. E. Poingdestre, Grass Valley, Cal.
Petaluma Gas & Electric Company, H. Weber, Petaluma, Cal.
Sacramento Electric Gas & Railway Company, Sacramento, Cal.
San Francisco Gas & Electric Company, W. J. Wrenn, San Francisco
San Luis Gas Company, Robert N. Frick and B. F. Thomas, San Luis Obispo, Cal.
San Rafael Gas & Electric Light Co., F. E. Fitzpatrick, San Rafael, Cal.
Spokane Gas Company, W. A. Aldrich, Spokane, Wash.
Stockton Gas & Electric Company, H. E. Adams, Stockton, Cal.
Suburban Electric Light Company, William Angus, San Leandro, Cal.
United Gas & Electric Company, C. H. Pennoyer, San Jose, Cal.
Woodland Gas & Electric Company, W. E. Osborn, Woodland, Cal.